STAFF REPORT

THE WESTERN DELPHI:
INSECTICIDE USE AND LINT YIELDS IN
WEEVIL-FREE AREAS OF THE COTTON BELT

May 1982

NRE
Economic
Research
Service

United States
Department
of
Agriculture

THE WESTERN DELPHI: INSECTICIDE USE AND LINT YIELDS IN WEEVIL-FREE AREAS OF THE COTTON BELT

May 1982

United States Department of Agriculture
Economic Research Service
Natural Resource Economics Division
Washington, D.C. 20250

The Western Delphi: Insecticide Use and Lint Yields in Weevil-Free Areas of the Cotton Belt. Natural Resource Economics Division, Economic Research Service, U.S. Department of Agriculture, Washington, D.C. 20250, May 1982

ERS Staff Report No. AGES820520

ABSTRACT

The Delphi, a method for systematic collection of information from experts, was modified to obtain biological data required for the economic analysis of current and potential cotton insect management practices in western regions of production where boll weevils do not pose a significant pest problem. Cotton insect management and crop production experts provided detailed data regarding current insecticide use patterns, and projected insecticide use and lint yields under an alternate, "optimal" insect management program. These data were used to estimate average cotton yield, insecticide use, and insect control costs under both current conditions and the alternative program for each of seven subregions of western cotton production.

Key words: Cotton, Delphi, insect control, insecticide use, pest management.

****
* This paper was prepared for limited distribution to the research community outside the U.S. Department of Agriculture. *
****

ACKNOWLEDGMENTS

Of principal importance to the generation of results reported herein are the 24 cotton expert Delphi panel members who contributed time and serious effort to the Western Delphi exercise. The computational expertise provided by Luis Suguiyama is gratefully acknowledged. Also, the typing skill and effort by Victoria Valentine and Linda Allen are appreciated.

PREFACE

This report provides estimates of farm level impacts of current and alternative cotton insect management practices in boll weevil-free areas of U.S. cotton production. These estimates are critical elements of the economic and environmental evaluations of alternative beltwide cotton insect management programs.

Estimated impacts on cotton producers' insecticide use and cotton lint yields were determined through a modified Delphi (expert opinion) process. The Economic Research Service (ERS) assumed overall responsibility for organizing and managing the Delphi, while other USDA and State agencies, industry representatives, and cotton producers provided the necessary expertise for estimating farm level data.

The Western Delphi project received leadership from Katherine Reichelderfer, ERS, who also prepared this report. Key members of the Western Delphi administrative team were: Katherine Reichelderfer (ERS)--Delphi Leader and Facilitator; Velmar Davis (ERS)--Overall Evaluation Leader; Gerald Carlson (N.C. State Univ.)--Facilitator; John Schaub (ERS)--Facilitator; Irving Starbird (ERS)--Facilitator, and Economic Evaluation Team Leader; Richard Ridgway (ARS)--Coordinator of Resource Material; Luis Suguiyama (N.C. State Univ.)--Computational Expert.

CONTENTS

TABLES

APPENDICES

THE WESTERN DELPHI: INSECTICIDE USE AND LINT YIELDS IN WEEVIL-FREE AREAS OF THE COTTON BELT

SUMMARY

Pesticide use and costs, and cotton lint yields were estimated for two cotton insect management options: current insect control practices (CIC); and adoption of optimum pest management programs (identified as OPM and involving increased Extension education). Estimates were made for each of seven specified areas in the three Western cotton-producing States. (Arizona, California and New Mexico). A modified Delphi was used to estimate insecticide use for each option, and to project yields under OPM.

Total changes in insecticide use and lint yields from CIC to OPM for the three-State region of cotton production are shown below.

Insect control option	Acre treatments w/insecticides	Total producers' insect control costs	Total cotton lint production
	Million acres	Million dollars	Million pounds
CIC (Baseline)	8	107	1,957
Change from CIC to OPM	-2	-21	+34

Insecticide use and costs, and lint yields vary by programs among Western cotton production subregions. Projected yield increases from CIC are greatest for Central Arizona and the Imperial Valley. In the San Joaquin Valley of California, a major cotton production subregion, yield is estimated to remain unchanged by a projected switch from CIC to OPM. Changes in insecticide use and producers' cost of insect control, between CIC and OPM, range from an estimated 50 percent increase in the Pecos Valley of New Mexico to a 29 percent decrease in Central Arizona.

These estimates represent farm-level impacts after full program implementation. They were used as input to an overall economic evaluation of alternative beltwide cotton insect management programs. Neither public cost nor off-farm impacts of the programs were addressed by the Delphi experts.

INTRODUCTION

The Cotton Insect Control Problem

Cotton is a major crop grown throughout the southern United States, where annual production is between 10 million and 14 million bales. Farm value of the 1979-80 crop was $5.1 billion. Profitable cotton production and effective insect control have been closely related for many years. The most important insects attacking cotton include the boll weevil, the pink bollworm, and the bollworm/budworm complex. In some areas, plant bugs such as lygus bugs and and the cotton fleahopper are also of particular concern. In recent years, cotton insects have caused estimated annual losses ranging from 7 to 19 percent of potential yield (9). Cotton producers spend about $300 million annually for foliar application of insecticides, plus additional costs for scouting and prophylactic and nonchemical control practices (12).

Evaluation of Beltwide Cotton Insect Management Programs

In recognition of the economic importance and potential environmental impacts of cotton insect control, two large areawide 3-year trials were conducted beginning in 1978 to test the technical and operational feasibility of alternative programs for cotton insect control. A Boll Weevil Eradication (BWE) trial was implemented in North Carolina and an Optimum Pest Management (OPM) trial was implemented in Mississippi. Concurrently, comprehensive biological, economic and environmental evaluations of Current Insect Control (CIC), and five alternative programs, including those tested in the trials, were conducted (9,10,11). These evaluations focused on the management of insects in the boll weevil-infested areas of the Cotton Belt only.

Review of the evaluations of the six cotton insect management programs for weevil-infested areas indicated a potential for extending the optimum pest management program into the weevil-free areas of the Cotton Belt. Subsequently, in 1981, a set of beltwide cotton insect management programs was evaluated (12).

The environmental and economic evaluations of beltwide cotton insect management programs required data on insecticide use, insect control costs and cotton lint yields for all cotton production regions under each alternative program. These data were previously generated for 35 subregions in the 11 boll weevil-infested States, using a modified Delphi approach (13). They had not, however, been estimated for cotton production regions in the States of California, Arizona or New Mexico, where boll weevils pose no problem. These three Western States contain approximately 18 percent of national cotton acreage and produce about one-third of the U.S. total cotton crop. The insect problems faced by producers in the West are different than those experienced in weevil-infested areas of the Cotton Belt. Thus, it was necessary to generate a set of data on insecticide use, insect control costs and cotton lint yields specific to the Western regions. This was accomplished by applying a modified Delphi approach that was similar to but distinct from the Delphi process used to collect data for the weevil-infested States.

This report defines the two cotton insect management programs for which Western cotton insecticide use and lint yield data were generated. The general Delphi approach and specific processes used to generate these data are reviewed. The Delphi results are presented, discussed and evaluated, and the Western Delphi process is critiqued.

PROGRAM DEFINITIONS

Insecticide use and lint yields for cotton production in California, Arizona and New Mexico were estimated for current conditions and one alternative insect management program--Optimum Pest Management. These programs were defined for evaluation as:

- Current Insect Control (CIC) assumes insect control as now practiced by producers, ranging from no control to intensive treatment with insecticides. Current insect control implies a continuation of extension education and technical assistance at the present levels of funding and resources.

- Optimum Pest Management (OPM) assumes provision of additional extension personnel and funds to provide increased technical information and educational guidance in the management of cotton insects. The objective of OPM is to reduce the number and costs of in-season treatments for cotton insects through effective scouting and monitoring and other effective pest management technologies. All available proven technology may be applied in implementing this program. Use of the technology recommended and participation in this program would be voluntary on the part of the grower. From 1 to 3 years may be required to fully implement the program, depending upon cotton acreage and availability of staff.

Western OPM

The general Western OPM Plan, shown as Appendix A, specifies a range of available technologies for cotton insect management in the Western States. The extent to which those technologies would be implemented depends, in part, upon the human resources available to extend information and lend technical assistance. The following table shows current levels of professional and technical manpower for cotton insect management as well as those levels that would be available under the OPM program:

State	Professional and Technical Man-Years	
	Current	OPM
California	2.2	6.5
Arizona	3.5	10.0
New Mexico	.4	3.0

Specific OPM plans for each State or cotton production area are a function of the level of increased resources, types of insect problems experienced, distribution of cotton and other agricultural acreage, and a range of other regional factors. Regional OPM technology implementation goals are specified later in this report.

THE DELPHI APPROACH

A modified Delphi approach was used to obtain from cotton management experts concensus estimates of current and projected insecticide use patterns and lint yields.

The Delphi approach provides for systematic collection of information from experts. It involves a high degree of intuitive judgment based on experience and other insights. Intuition and judgment are indispensable ingredients of research and analysis in the social sciences and frequently supplement quantitative models in the natural and biological sciences as well.

The Delphi method was developed by the Rand Corporation in the 1950's and first used to estimate the probable effects of an atomic bomb attack on the United States. Since then, it has had widespread use in technological forecasting, and its uses have proliferated (5).

While no single definition of the Delphi is appropriate for all applications, the following characterize the approach. Delphi is: "a method for structuring a group communication process so that the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem" (5); "a technique used for the elicitation of opinions with the object of obtaining a group response for a panel of experts" (1); and "characterized by three features which distinguish it from the usual methods of group interaction. These are: (a) anonymity; (b) iteration with controlled feedback; and (c) statistical group response...The Delphi is not really a single method, but a family of methods, basically all modifications of, or variations on, the approach developed at Rand" (6).

The Delphi is adaptable to a wide range of inquiries, but the specific form or structure of the communication process should match the objective and not be rigidly applied over all possible applications. As a minimum, however, the Delphi was designed to provide for four underlying processess: (a) Some feedback of individual contributions or responses; (b) Some assessment of the group judgment or view; (c) Some opportunity for individuals to revise their responses; and (d) Some degree of anonymity for the individual responses.

The value of the Delphi approach for collecting data on complex biological relationships, including the relative advantages and disadvantages of the approach, are discussed by Reichelderfer and Starbird (8). Basically, the Delphi provides a reasonable approach to collection of data that are unavailable and cannot be generated by more precise, analytical methods. It applies particularly well to the examination of situations that are too complex to dissect by conventional means, to projection of the impacts of events that

could occur in the future but have not been experienced to date, and to generation of data that must apply consistently over a large heterogeneous set of units. To some extent, all of these conditions existed with respect to insecticide use and lint yields in the Western States. These variables are the result of complex interactions among the cotton crop, the various insect and other pests attacking the crop, and the perceptions and objectives of the cotton producer. The impact of OPM could not be scientifically determined since it has not been implemented on an areawide basis in the West. Finally, comparable, consistently derived data were required for seven subregions of Western cotton production, each of which experiences a different climate and set of insect problems.

The Delphi can be structured so that it capitalizes on the availability of informed, expert opinion on a collective basis while preventing undue bias inherent to subjective judgment made on an individual basis. This was the intent of the "Western Delphi." The objective was to determine from a varied group of cotton experts its best expectations regarding insecticide use and cotton yields under both CIC and OPM. These experts would draw on their broad and varied experiences with cotton production, pest control, farmer behavior, geographical considerations and other relevant factors to derive valid and consistent estimates of those necessary data sets.

THE WESTERN DELPHI

A well rounded, diverse group of cotton management experts, and a systematic method for collecting and examining these experts' judgments are the basic ingredients necessary for an effective Delphi exercise. An additional requirement for this particular Delphi process was that it had to yield data that were comparable to and could be integrated with the Delphi data previously collected for the boll weevil-infested portion of the Cotton Belt. The following sections describe the organization and processes used to meet these objectives.

Organization of the Western Delphi

The organization of expert panels was based on major cotton production regions within the three States of Western cotton production. Figure 1 deliniates the boundaries of the four Delphi regions for which panels were organized. Panel F represented New Mexico and considered three different subregions of cotton production within that State--Upper Rio Grande (subregion 38), Pecos Valley (subregion 37), and Southern Plains (subregion 36). Panel G represented Central Arizona and considered two different subregions--Southeast Arizona (subregion 39), and Central Arizona (subregion 40). Panel H represented a relatively homogeneous region of cotton production comprised of Yuma and Mohave Counties, Arizona, plus Imperial and Riverside Counties, California (subregions 41 and 42). Panel I represented the San Joaquin Valley production area (subregion 43).

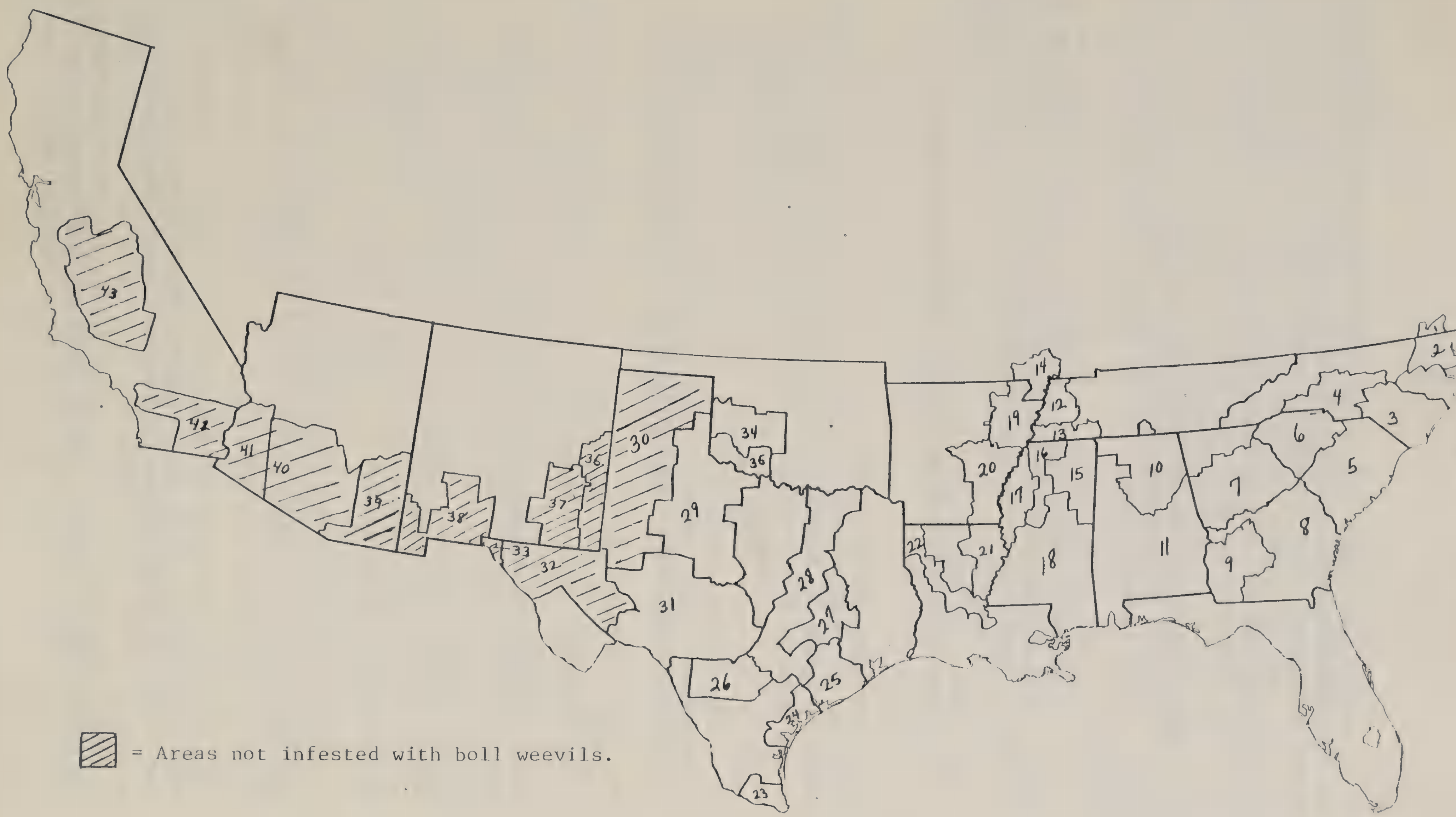

Figure 1. Cotton Production Regions.

Panel members were drawn from a range of backgrounds, each of which incorporates different experiences and perspectives concerning cotton insect management. Invitations to participate in the Western Delphi exercise were extended to: cotton extension entomologists and/or agronomists; cotton research entomologists; cotton producers; independent pest management consultants; chemical industry representatives; and State Department of Agriculture representatives. Each panel, with the exception of the New Mexico group, contained at least one member from each of the groups specified. A total of 24 individuals served on the expert panels. Appendix B lists the participants on each panel.

A group facilitator was assigned to each of the four regional Delphi panels. The facilitators' responsibilities were to (a) direct and guide the process of data collection from the regional Delphi panels, (b) prevent domination or undue biasing by any individual or subgroup of the panel, (c) receive individuals' feedback to the group's interim results, and (d) facilitate arrival at a group concensus response to the Delphi questionnaire.

Each panel also had associated with it a "Resource Person", an individual possessing unique expertise in various aspects of cotton insect management. The Resource Persons' responsibilities were to (a) provide background material to the Delphi panel members that would aid them in developing realistic cotton insect management data, (b) clarify or supplement information on specific technical aspects of cotton insect management as needs were identified by a Delphi panel or panel member, and (c) respond, react and provide feedback to panel members and facilitators on interim Delphi results.

The Delphi Questionnaire

A questionnaire was used to collect experts' opinions on cotton insect management. The Delphi questionnaire (Appendix C) was developed by a group comprised of representatives from the Economic and Biological Evaluation teams and the Delphi Resource Group. The basic matrix provided for the collection of information is identical to that used for the Delphi conducted in boll weevil-infested areas. However, additional questions regarding nonchemical pest control technologies, and cotton lint yield under improved pest management were included in the Western Delphi package.

The questionnaire was specifically designed so that experts were asked to estimate the underlying factors that determine cotton yield and insect control costs under various management options. There are three reasons for this design.

First, outright estimates of yield and especially cost changes are more difficult to provide than are the changes in management variables that result in those changes. Also, each expert could have a different perception of the term "average change." Some may think in terms of a strict statistical "mean" average, whereas others could interpret the term as being the most common change observed--statistical mode. By asking for the probability distributions that determine an average

value and its variability, internal consistency of the bases upon which estimates were made was preserved. Each expert was guided to use the same thought process. Lastly, asking for the component relationships that lead to changes in yield and insecticide use provides information needed to substantiate or show the reasons for the observed estimated changes.

Appendix C is a copy of the questionnaire that was developed and used in the Western Delphi process. The assumptions used in deriving responses, and a brief description of each question follows.

Experts were asked to provide information on current cotton insect control practices (CIC) as well as on expected control patterns under optimum pest management (OPM) implementation. The panel of experts was asked to use the following assumptions in providing that information.

1. CIC represents practices over the past five years, with currently known and used technology.

2. Beneficial insects are at average population levels under CIC.

3. CIC descriptions show what cotton producers are doing, not what experts think they should be doing or will be doing in the future.

4. Infestation level is defined in terms of the duration of the cotton season an insect complex is present, the percent of acreage infested, the level of the pest population, and the susceptibility of the cotton fruit.

5. OPM is fully implemented and represents the results of adding specified amounts of new Extension resources to a given region and attempting to achieve the "ideal" (as defined by Extension) set of regional insect management strategies. Panel members estimated the extent to which the ideal conditions would be met.

6. OPM implementation would involve utilization only of currently known and available pest management technologies, i.e.: technology is assumed constant.

7. Cotton acreage will not change given OPM implementation.

The questionnaire requests the following information, which was collected on a subregional basis for both of the management programs considered.

1. A listing of target insect complexes and the associated acreage on which each is typically a problem.

2. The insecticide materials used in-season against each target insect complex and the proportion of infested acreage treated and average application rate of each material used.

3. The number of times per year that each specified insecticide material is applied to acreage experiencing zero, light, moderate and heavy infestations of the target insect complex against which it is used.

4. The probabilities of zero, light, moderate and heavy infestation by the target insect complex.

5. The prophylactic and/or nonchemical pest management technologies, including scouting, used against each target insect complex, the proportion of acreage on which each of these practices occurs, and the average per acre cost of each of these practices.

Note that this information provides the data required to estimate insecticide use and total insect control costs without asking for direct estimates of those essential variables. Average cotton lint yields under current insect control were known, but estimates of yields under OPM were required. Thus, with respect to OPM only, the following sixth set of information was requested:

6. The average change in per acre cotton lint yield expected to result from a switch from CIC to OPM, a list of factors contributing to the projected yield change, and designation of the proportional contribution of each factor to the total yield change.

The Western Delphi Process

The Western Delphi was conducted during a two-day session in July 1981. All participants met face-to-face to develop insecticide use and lint yield estimates. The process consisted of several distinct but interdependent phases, each of which is reviewed below.

As a first step, preparatory to the actual Delphi exercise, cotton Extension pest management experts defined for each region an ideal, regional pest management scenario. These descriptions were based on the generalized OPM program described in Appendix A and involved Extension personnel's identification of the extent to which each of a range of insect control technologies would be utilized to provide the best possible regional cotton insect management. The descriptions, which are briefly summarized in Table 1, were considered goals for OPM implementation. They were constructed to provide upper bounds, only, on the possible impact of increased Extension resources to a given region, and to be used as a guide for Delphi panels in considering OPM.

The actual Delphi exercise was conducted in regional group meetings. Each panel met separately and its first task was to describe, using the Delphi questionnaire, the current pattern of cotton insect control observed for its subregion(s). This was accomplished in several steps. First, individuals responded anonymously, and without discussion, to the questionnaire asking for information on CIC, by target insect complex. As individuals' responses were completed for a given section,

Table 1. Estimated current levels of cotton insect control technology, and Extension specified goals for technology utilization under OPM, by Western subregion of cotton production.

Technology	Technical assistance and technology utilization under CIC and OPM													
	San Joaquin Valley		Imperial and Riverside Counties, CA		Yuma and Mohave Counties, AZ		Central Arizona		Southeast Arizona		New Mexico Southern Plains		New Mex. Pecos and Rio Grande Valleys	
	CIC (1.6 S.Y.'s)	OPM Goals (3.9 S.Y.'s)	CIC (0.6 S.Y.'s)	OPM Goals (2.6 S.Y.'s)	CIC (1.5 S.Y.'s)	OPM Goals (2.5 S.Y.'s)	CIC (2 S.Y.'s)	OPM Goals (6.5 (S.Y.'s)	CIC –	OPM Goals (1 S.Y.)	CIC (0.5 S.Y.)	OPM Goals (1 S.Y.)	CIC (0.3 S.Y.)	OPM Goals (2 S.Y.'s
	percent cotton acreage on which technology used													
Recommended planting and harvesting dates	100	100	< 2	75	< 1	100	25	75	70	100	80	90	75	90
Recommended cotton varieties	100	100	100	100	100	100	100	100	100	100	90	95	70	5/
Insect scouting and reports (weekly or biweekly)	90	1/	50	95	75	100	50	90	80	95	15	60	8	80
Insect traps for monitoring and recommendation	100	100	30	95	33	100	50	4/	< 1	4/	0	85	0	85
Recommendations for insect control based on economic thresholds	90	1/	30	95	25	100	60	95	80	95	60	90	75	90
Biological control of HELIOTHIS complex	2/	2/	< 5	95	20	100	60	95	80	95	65	75	45	75
Alternate hosts for Lygus	90	1/	where applicable		100	100	15	90	0	20	5	20	5	25
Recommended chemical control	90	1/	50	90	60	100	70	90	80	95	55	85	65	85
Glossyplure control of pink bollworm	0	0	3/	3/	15	100	4/	4/	80	95	0	3/	0	6/
Pest and plant development prediction systems	0	100	0	100	0	100	20	90	20	80	40	90	30	90

1/ Improvement to come from increased precision of practice rather than significant increases in acreage covered.
2/ Not a serious problem in San Joaquin. Dependence is on naturally ocurring beneficial species.
3/ Not a proven technology. Demonstrations presently being conducted. If found effective, 100 % coverage will be recommended.
4/ Still in research and development phases.
5/ To be determined as new varieties are developed and tested.
6/ Currently not an economic problem in Pecos and Rio Grande Valleys.

the facilitator made a simple listing of responses, without attaching respondents' names to entries on the list, and displayed it to the group. This step was meant to stimulate discussion and interchange of ideas, and focused on those responses that laid at the outer ranges of the majority of responses. The next step was to develop, on the basis of the group discussion, a single, group concensus response to each item on the CIC questionnaire. If a strict concensus could not be reached, average values and the range of responses were filled in for the first group set of responses. This "concensus" questionnaire was then given to a computation expert who, on the basis of the probabilities estimated by the Panel and a fixed set of insecticide materials and application costs (shown in Appendix D), calculated the average per acre number of insecticide applications and insect control costs implied by the group response. This was done to give the panel members comprehensive measures of the first-cut CIC description they provided. It allowed them to compare the results of the concensus questionnaire response to their own views of per acre insecticide use and costs, and with published data related to those measures. The final step of CIC description involved revision and refinement of the concensus questionnaire based on panel reaction to the results of the computation. The revised concensus questionnaires represent the final Western Delphi CIC estimates.

A similar procedure was followed for elicitation from the panels of regional OPM estimates. The steps involving individual response, concensus response and concensus revision were followed, but with several differences from the CIC estimation procedure. First, panel members' estimation of the extent to which various insect control technologies would be utilized under OPM was based on two sets of data provided them -- the specified level of additional Extension input defining OPM, and the Extension goals for OPM implementation (both shown in Table 1). It was up to the Delphi panels to determine the extent to which they felt Extension goals could be realized, but their estimates of the percentage use of each technology had to fall within the range defined by their own CIC estimates and the Extension goals. A second difference from the CIC exercise involved the additional step to estimate cotton lint yields under OPM. Yield change estimates, like those for insect control practices, were obtained as group concenses.

WESTERN DELPHI RESULTS

The fourteen concensus questionnaire response sets describing CIC and OPM for each of seven subregions of Western cotton production comprise the primary Western Delphi results. These group concensus estimates are shown in complete detail as Tables E-1 through E-13 in Appendix E. Summary data on insecticide use, insect control costs and cotton lint yields, derived from the concensus questionnaires are shown in Tables 2, 3 and 4.

Average per acre CIC insecticide use and associated costs vary greatly among the Western subregions. This variation is a function of differences among subregions in such factors as climate, soil type,

altitude, intensity of cotton production, proximity of cotton to other crops (e.g., alfalfa), and type and severity of insect problems. The Delphi estimates show that under current, average conditions insecticides are used more intensively on cotton acreage in the Imperial-Yuma area than in the other Western subregions. The data indicate expenditures on insect control in the Imperial Valley average about 15 cents per pound of harvested lint. On the other extreme are Southeastern Arizona and the New Mexico regions where, according to the Delphi data, less than one insecticide application per acre currently is made on the average, and estimated insect control costs are under five cents per harvested pound of lint.

CIC average cotton lint yields were not generated by the Delphi panels. Baseline CIC yields are represented by actual, observed average yields for the period 1977-79. To derive an indication of the estimated impact on yields, costs or insecticide use, of a change to OPM, comparisons should be made against the CIC or baseline estimate.

OPM Estimates

Estimated impacts of the addition of specified amounts of new Extension input on insect control patterns vary across Western subregions. Over most acreage OPM implementation would decrease insecticide use and increase the use of scouting and cultural practices for cotton insect control. OPM is projected to reduce average, in-season insecticide use by as much as one-third application per acre in the San Joaquin Valley to a maximum of 3.3 applications per acre in Central Arizona. However, in Southeast Arizona, OPM would have no effect on insecticide use, and in New Mexico would slightly increase in-season insecticide use by between one-twentieth and 3/4 of an application per cotton acre. Whether the change from CIC to OPM results in an estimated net increase or decrease in the number of applications depends upon whether the current pattern of use is seen as one of overutilization or underutilization of insecticides. The fact that a net reduction was projected for California and most of Arizona suggests panel members generally viewed CIC as employing more than the optimal number of applications in those regions and also that they believed additional Extension personnel would be effective in improving the timing and other aspects of current insecticide use. The estimates for New Mexico suggest that in that State insecticides currently are underutilized and slight increases in insecticide use would improve cotton production there. The largest projected increase in the use of scouting and cultural practices occurred for Central Arizona, the subregion for which estimated reductions in insecticide use also are greatest. This suggests a projected substitution of information and cultural practices for insecticides to control cotton insects'. In all subregions, projected impacts of OPM on producers' costs exhibited the same trend as insecticide use due to their relatively direct relationship with the number of applications.

Table 2. Delphi estimated number of in-season insecticide applications and proportions of acreage on which scouting and post harvest operations are utilized for insect control under CIC and OPM in regions of Western cotton production.

Region	Average per acre number in-season insecticide applications		Proportion of cotton acreage scouted for insects		Proportion of acreage on which stalk destruction, fall plow down or other post harvest operations are practiced for PBW control	
	CIC	OPM	CIC	OPM	CIC	OPM
San Joaquin Valley	2.1	1.75	90	90	0	0
Imperial Valley (Imperial and Riverside Cos., CA and Yuma and Mohave Cos., AZ)	11.7	10.2	100	100	71	75
Central Arizona	6.1	2.8	90	100	25	50
Southeast Arizona	0.12	0.12	N/A	N/A	N/A	N/A
New Mexico - - Upper Rio Grande	0.03	0.12	75	80	95	95
New Mexico -- Pecos Valley	0.78	1.5	86	100	90	90
New Mexico - - Southern Plains	0.17	0.22	15	35	N/A	N/A
Total, Western Regions	3.7	2.8				

Table 3. Delphi estimated insect control costs, per acre, under CIC and OPM in regions of Western cotton production.

Region	Current insect control: Per acre cost of in-season insecticide use	Current insect control: Per acre cost of prophylactic and nonchemical insect control practices 1/	Current insect control: Total per acre cost of insect control	Optimum pest management: Per acre cost of in-season insecticide use	Optimum pest management: Per acre cost of prophylactic and nonchemical insect control practices 1/	Optimum pest management: Total per acre cost of insect control	Change in total per acre insect control costs, from CIC to OPM
	dollars per acre						
San Joaquin Valley	25.17	26.72	51.89	18.96	26.72	45.68	-6.21 (12%)
Imperial Valley (Imperial and Riverside Cos., CA and Yuma and Mohave Cos., AZ)	166.17	17.34	183.51	141.22	18.19	159.41	-24.10 (14.5%)
Central Arizona	64.95	5.45	70.40	38.84	11.33	50.17	-20.23 (29%)
Southeast Arizona	0.84	2.10	2.94	0.84	2.10	2.94	0
New Mexicm $2- Upper Rio Grande	0.25	19.92	20.17	0.84	22.30	23.14	+2.96 (15%)
New Mexicm $2							

Table 4. Delphi estimated average cotton acreage (1977-79), CIC average per acre cotton lint yield (1969-78), and projected change in cotton lint yield and production from CIC to OPM in regions of Western cotton production.

Region	Average acres cotton harvested, 1977-79	Average cotton lint yield, 1969-78 (lbs. per acre)	Percent change in cotton lint yield, CIC to OPM (percent)	Change in total cotton lint production, from CIC to OPM 1/ (Million pounds)
San Joaquin Valley	1,361,333	904	0	0
Imperial Valley (Imperial and Riverside Cos., CA and Yuma and Mohave Cos., AZ)	229,434	1,048	+2.8	+6.85
Central Arizona	394,967	1,029	+5.2	+21.13
Southeast Arizona	45,633	628	0	0
New Mexico - - Upper Rio Grande	49,770	570	+6.8	+1.93
New Mexico - - Pecos Valley	35,563 2/	543	+16.2	+3.13
New Mexico - - Southern Plains	41,238 2/	314	+5.3	+0.68
Total, Western Regions	2,157,938	907	+1.7	+33.72

1/ Assumes no change in cotton acreage

2/ Adjusted to reflect more typical proportion of planted acres harvested than was experienced 1977-79.

The estimated effect of OPM on yield ranges from no change in the San Joaquin Valley and Southeast Arizona to an increase in average lint yield per acre of from 17 pounds in the New Mexico Southern Plains to 88 pounds in the Pecos Valley of New Mexico. The Delphi data suggest the benefits of OPM in the San Joaquin Valley would be restricted to reductions in the cost of producing cotton where, in the other Western subregions, benefits would be derived both from cost reductions and yield increases. A range of factors were identified as making major contributions to the net yield increases attributed to OPM. In the Imperial-Yuma area, yield was projected to increase as a function of increased planting at recommended dates, crop rotation, scouting and trapping, and decreased use of azodrin and other organophosphate materials. In Central Arizona the projected five percent increase in lint yield would result from improved overall cotton management. In New Mexico the primary factor contributing to yield increases under OPM was identified as "increased fleahopper and lygus control with increased bollworm control, off-set by the use of biologicals and low rates of selective insecticides."

Evaluation of Western Delphi Estimates

Comparison of the Delphi estimates with related published data and information provides some indication of the relative validity of the results of the Western Delphi. Historical data bases on cotton insect control practices are available only for comparison with Delphi CIC estimates. Results of similar and related studies are available for use in drawing some general conclusions with regard to the probable accuracy of OPM estimates.

USDA periodically has conducted surveys of cotton growers to determine the cost and/or extent of use of pesticides on cotton. Surveys are based on a sample of cotton growers and, until 1979, provided results that could be considered valid only at regional and national levels of aggregation. Cooke and Parvin summarized data obtained from a variety of surveys, specific to the crop years 1969, 1972, 1974 and 1977 (2). Results of a 1979 USDA survey of pesticide use on cotton also are available for comparison purposes (7). Tables 5 and 6 show selected results from the year-specific surveys, along with Delphi CIC estimates that have been aggregated to levels appropriate for direct comparison purposes.

Although it is difficult to draw inferences from a comparison of year-specific data collected for distinctly different purposes with the normalized (5 year average) Delphi CIC estimates, some general conclusions can be reached through examination of Tables 5 and 6. First, the Delphi estimated average number of in-season insecticide applications on cotton in the 3-State Western region, 3.7 applications per acre, falls directly within the range of observations on that variable provided by surveys conducted in five different years. This suggests close correspondence of regional aggregated Western Delphi insecticide use data with actual current conditions. On State and subregion levels, the degree of correlation is more difficult to determine. Delphi State-level estimates of the average number of insecticide applications per acre 1976-80 for California and Arizona are higher

than the average number observed during 1979. Since 1979 is generally known as a crop year for which cotton insect infestations were atypically light, this is not surprising. Delphi estimated CIC insecticide use in the San Joaquin Valley is highly representative of usage observed for the years 1969, 1972, 1974 and 1977. Delphi estimated insecticide use for the Imperial-Yuma area is higher, and for New Mexico is lower than that observed in years for which comparable data are available. However, the Delphi data on insecticide use generally express the same relative interstate and interregional differences as do the pesticide survey data.

Next, Delphi CIC estimated average per acre insecticide materials costs are similar to or higher than those estimated for subregions from survey data but lower than those estimated at the State level from FEDS budget generation. The fact that they generally fall between the extremes defined by survey and FEDS data suggests they may be relatively accurate estimates of current, average expenditures.

Little or no hard data are available for comparison with Delphi OPM estimates. The contribution of neither Extension nor research input to cotton production with respect to insect control has been empirically examined. The Delphi results, which indicate that OPM could have a significant, positive impact on yields, are, however, supported by the findings of Griliches and others. Griliches' classic study found that investments in human capital and agricultural research and extension have historically made significant contributions to increases in agricultural output (3). Additionally, the observation that cotton growers are increasingly employing the services of private pest management consultants suggests that they too perceive a net benefit to information provision and technology transfer.

The type and general direction of yield change implied by the Western Delphi OPM data are the same as those projected to occur in the boll weevil-infested portions of the Cotton Belt under OPM-NI, a comparable program (13). However, the 1.7 percent average yield increase estimated for the three-State Western region is more moderate than the 3.5 percent overall yield increase estimated to occur under identical circumstances in the 11-State boll weevil-infested area.

CRITIQUE OF THE WESTERN DELPHI

All Delphi participants were asked to provide an anonymous, retrospective critique of the Delphi process and its results. A Delphi Critique Form (Appendix E) was mailed to each of the panel members, resource persons, facilitators and administrators. Their response rate was 81 percent. The response pattern to each item is shown in Appendix E. Selected results are discussed below.

The Western Delphi panelists generally felt they possessed or were provided the background information necessary to respond to the questionnaire. A total of 78 percent of respondents to the critique

Table 5. Comparison of Delphi estimated average number of insecticide applications per acre with year-specific data on cotton insecticide use in 1969, 1972, 1974, 1977 and 1979.

Area or State	Number of insecticide applications per harvested cotton acre					
	1969 1/	1972 1/	1974 2/	1977 2/	1979 3/	Delphi average, CIC
San Joaquin	2.0	2.1	2.1	1.8	-- 4/	2.1
Imperial (Imperial and Riverside Cos., CA. and Yuma and Mohave Cos., AZ)	7.5	9.4	7.5	9.4	--	11.7
California	--	--	--	--	2.0	2.9
Central Arizona	4.0	9.7	7.5	--	--	6.1
Southeast Arizona	0.8	--	--	1.1	--	0.1
Arizona	--	--	--	--	4.8	6.6
New Mexico	6.5	1.1	--	1.1	0.6	0.3
Total, average for 3 Western States	3.2	3.8	3.4	4.1	2.6	3.7

1/ Calculated from information provided by Cooke and Parvin (2).

2/ From Cooke and Parvin (2).

3/ From USDA 1979 Cotton Pesticide Use Survey (7).

4/ Not reported

Table 6. Comparison of Delphi estimated average insecticide materials costs per acre with year-specific data on insecticide costs in 1969, 1972, 1974, 1977, 1978 and 1979.

Area or State	Estimated average insecticide materials costs per harvested cotton acre						
	1969 1/	1972 1/	1974 1/	1977 1/	1978 2/	1979 2/	Delphi average, CIC
	1979 constant dollars						
San Joaquin	11.07	20.06	12.21	7.05	-- 4/	--	15.41
Imperial (Imperial and Riverside Cos., CA, and Yuma and Mohave Cos., AZ)	33.46	77.95	41.11	33.70	--	--	118.20
California	--	--	--	--	39.09	34.98	23.96
Central Arizona	24.96	63.05	37.74	-	--	--	47.99
Southeast Arizona	12.20	--	--	2.55	--	--	.51
Arizona	--	--	--	--	120.91	108.18	57.90
New Mexico	27.99	17.50	--	2.55	3.99	3.57	1.17
Total, average for 3 Western States	17.10	31.49	19.61	15.17	57.44	51.39	30.18

1/ From Cooke and Parvin (2).

2/ From Krenz, et al. (4).

3/ Calculated from Delphi total per acre in-season costs by subtracting average application costs.

4/ Not reported.

form agreed to some extent that the questions on the Delphi questionnaire were precise and unambiguous, but 60 percent report they experienced some degree of difficulty in utilizing the questionnaire. Responses by panel members indicate the facilitators were successful in ensuring that the panelists had the opportunity both to anonymously and outwardly disagree with one another. A total of 95 percent of the panel members report they would be willing to participate in another similar Delphi exercise if given the opportunity to do so.

Panel members, facilitators, administrators and resource personnel all agreed the Delphi panels included individuals possessing a range of perspectives and experiences, and the majority (96 percent) agreed also that the panels were comprised of individuals with a high degree of expertise, and were not biased with respect to overrepresentation by any one subgroup of individuals.

The participants' reported degree of satisfaction with the Delphi results is an important subjective indication of the validity of the Western Delphi data. A total of 82 percent of respondents agreed to some extent with the statement that "The Delphi estimates are realistic representations of the average situation expected for an average year under the conditions described by program definitions." Only six of the 28 respondents disagreed with that statement. There was even more agreement with the statement that "The Delphi results provided the best possible estimates...given (the) current state of knowledge and time constraints." Only four respondents report they believe the Western Delphi process could have benefitted from additional time to study and review results. The majority, however, agreed the process period was sufficient in length. These critiques demonstrate good to high satisfaction of the participants with the output of their efforts.

REFERENCES CITED

1. Brown, Bernice B. Delphi Process: A Methodology for the Elicitation of Opinions of Experts. California, P-3925, September 1968.

2. Cooke, F.T., Jr. and D.W. Parvin, Jr. "The Cost of Insecticides Used on Cotton in the United States." Chapter 2, Cotton Insect Management with Special Emphasis on the Boll Weevil, U.S. Dept. of Agriculture, ARS Handbook (in press).

3. Griliches, Zvi. "Research Expenditures, Education, and the Aggregate Agricultural Production Function," American Economic Review, 54(4): 961-974, December 1964.

4. Krenz, Ronald, Charles Michael, David Fawcett, and Stanley Rogero. Costs of Producing Food Grains, Feed Grains, Oilseeds, and Cotton, Selected years. Economic Research Service, U.S. Dept. of Agriculture, Agricultural Economic Reports.

5. Linstone, Harold A. and Murray Turoff, editors. The Delphi Method: Techniques and Applications. Addison-Wesley Publishing Co., Reading, Mass., 1975.

6. Martino, Joseph P. Technological Forecasting for Decisionmaking. American Elsevier Publishing Co., New York, 1972.

7. McDowell, Robert M., Craig Osteen and Cleveland Marsh. Insecticide and Nematicide Use on Cotton in the United States in 1979. U.S. Dept. of Agriculture, ERS Staff Report (in press).

8. Reichelderfer, Katherine and Irving R. Starbird. "A Delphi Process for Obtaining Biological Data for Economic Evaluation," 1981 Proceedings, Beltwide Cotton Production Research Conferences, New Orleans, January 1981, pp. 212-217.

9. U.S. Department of Agriculture, Science and Education Administration--Agricultural Research. Biological Evaluation, Beltwide Boll Weevil/Cotton Insect Management Programs. SEA-AR Staff Report, April 1981.

10. U.S. Department of Agriculture, Economic Research Service. Economic Evaluation, Beltwide Boll Weevil/Cotton Insect Management Programs. NRED, ERS Staff Report No. AGESS810518, June 1981.

11. U.S. Department of Agriculture, Animal and Plant Health Inspection Service. Environmental Evaluation, Beltwide Boll Weevil/Cotton Insect Management Programs. APHIS 81-33, 1981.

12. U.S. Department of Agriculture, Economic Research Service. Evaluation of Beltwide Cotton Insect Management Programs. ERS Staff Report (in press).

13. U.S. Department of Agriculture, Economic Research Service. The Delphi: Beltwide Boll Weevil/Cotton Insect Management Programs. ERS Staff Report No. AGESS810507, May 1981.

APPENDIX A

Western OPM Plan

Prepared By

Leon Moore

Extension Entomologist
University of Arizona
Tucson, Arizona

Western OPM Plan

I. Operational Regions and Units

There are four identifiable regions in the Western Cotton Production area for OPM Programs. These include (1) The San Joaquin Valley, California; (2) The Imperial Valley, California and Yuma and Mojave Counties, Arizona; (3) Central Arizona; and (4) Eastern Arizona and New Mexico. The key pests in Region 1 are lygus bugs and spider mites. Bollworms are sometimes a problem as secondary pests and light, but chronic infestations of pink bollworms are of concern. In Regions 2, 3, and 4, pink bollworms and lygus bugs are key pests while tobacco budworms, bollworms, cotton leafperforators, and spider mites are major problems in some areas. An infestation of boll weevils in Region 3 is of concern.

OPM programs will require custom development for each region and in most cases for areas within regions. Large farms are common in all areas, but especially in Regions 1, 2, and 3. However, small to medium sized farms are present in all regions.

Pest management programs are presently operational in all areas. Delivery is by grower cooperatives, private consultants, and chemical company representatives. The extent to which these programs utilize available pest management technology is variable.

Some factors that will influence establishment of OPM units are: (1) the severity of pest problems, (2) the pests involved, (3) natural area boundaries, (4) location in relation to extension service facilities, (5) size of farms, (6) acreage involved, (7) grower attitudes toward OPM, and (8) present and potential

qualified extension service personnel available. Unit size will be determined primarily by natural boundaries, pest problems, and available pest management personnel.

Personnel requirements for each unit will vary, but will include a pest management specialist and support personnel. These personnel will operate in an educational capacity. All other program costs will be the responsibility of the growers involved.

II. Basic Program Elements

1. Sampling

All fields will be scouted at least weekly and recorded field data collected will be provided to growers and supervisors. Scouts will be trained by extension service pest management personnel. Scouts will be employed and supervised according to the type of OPM delivery chosen by the growers involved.

Pre-season and in-season scout training by extension service personnel will be intensified. All interested persons, including growers, will be invited to participate in the training sessions.

2. Monitor Traps

Traps containing gossyplure for pink bollworm, virelure for tobacco budworm, zealure for bollworm, and grandlure for boll weevil will be used to monitor populations where applicable. Data from these traps will be used to supplement field scouting information.

3. Predictions Based on Heat Units

A weather station network will be used in each unit to provide data needed for pest and plant development prediction. A computer network with terminals at extension facilities and at grower headquarters will permit access to this predictive capability. This information will permit greater efficiency in the decision making process.

4. Economic Levels

Economic levels for the major pests will be published along with control suggestions. An educational effort will be made regarding the availability and usefulness of economic levels for the pests of each program unit. Research involvement will be encouraged to improve and refine economic levels and program suggestions will be up-dated as needed.

III. Control Components

The best combination of control components available for a given area will be suggested for implementation. The components used in a given unit will depend primarily on the pest or pest complex in the area. Components from which the best combination will be chosen include the following:

1. Planting and Harvesting Dates

The pink bollworm is especially susceptible to manipulation of planting and harvesting dates. Suggested dates for planting and terminating the crop for maximum detrimental effect on the pink bollworm and compatible with optimal yields will be emphasized to participants. The weather station network will be

used to provide information for using heat unit accumulations to determine optimal planting dates. Crop termination dates will be suggested based on diapause data available for the pink bollworm. In general, this requires termination of fruiting by mid September.

2. Varietal Selection

Varieties with resistance to pests such as the nectariless cottons will be suggested whenever applicable and where they are expected to yield competitively. In addition, varieties that yield competitively with a shorter growing season will be suggested.

3. Alternate Host Management for Lygus Bug Control

An alternating pattern of harvesting alfalfa to keep lygus bugs in this favored host will be suggested in all areas. This can be accomplished by block-cutting or strip-cutting at approximately two week intervals and results in greatly reduced migration into cotton. Safflower, another favored host, will be monitored and treated with an appropriate insecticide when most of the single generation produced in the crop is in the late nymphal stage. This usually occurs in late May or early June at about the time cotton begins to square. More exact timing will be accomplished by use of heat unit information.

4. Biological Control

Lygus bugs are the first pests of general concern in most areas. Management practices in alternate hosts will be emphasized to reduce migration into cotton and the subsequent necessity of

chemical control. This will permit use of parasites and predators well into the season to control other pests, particularly the *Heliothis* complex. The wide range of abundant naturally occurring beneficials will be conserved and used to the greatest extent possible in all areas.

Use of a microbial insecticide will be suggested when *Heliothis* is the first pest of concern. *Bacillus thuringiensis* and the virus Elcar will be suggested in combination with a feeding stimulant. These products will suppress the *Heliothis* populations without disrupting natural control by parasites and predators.

5. Pheromone Control

Gossyplure will be suggested in some areas for pink bollworm suppression. Mass-trapping, using 5-8 traps per acre or confusion applications based on monitoring data will be used, particularly for early season suppression, to delay the development of economic infestations. These control methods are compatible with effective use of natural control forces.

6. Chemical Control

Use of insecticides will be suggested when economic levels are reached based on field sampling. The final decision regarding when to control and the chemical to use will be the responsibility of the grower or his designated representative. Annually revised insecticide suggestions will be made available to all growers. These suggestions will provide information on effective insecticides and the population level when treatment should be applied. Emphasis in chemical control will be placed on selecting the best

material, using the proper dosage, determining proper timing, and obtaining good application. Selective materials, those considered "easy" on beneficials and ovicides will be used according to pest conditions. Because of the increasing importance of spider mite infestations, the miticidal activity of all materials will be considered. Careful consideration will be given to potential hazards to man and the environment, especially in areas of urban and agriculture interface.

7. Cultural Control

The pink bollworm is especially susceptible to control by cultural practices because of its life and seasonal histories and its very limited host range. Weak points when the pest is vulnerable to control include the overwintering period spent primarily in cotton fields, the emergence period in the spring, and the diapause period in the fall. Delayed planting, early harvest, and the use of good yielding varieties that terminate early will be suggested as management practices.

Each fall and winter tillage practice destroys some of the overwintering larval population and reduces the subsequent spring emergence. Following stalk destruction, discing and plowing will be encouraged. The planting of a winter grain crop is also detrimental to overwintering pink bollworms.

Supplemental irrigations during the winter destroy pink bollworms and other pests. Careful timing of in-season irrigations will also be used to manage pest populations.

Although most of the cultural practices are aimed at pink bollworm control, they are generally also beneficial in reducing other pest populations.

APPENDIX B

ORGANIZATION OF THE WESTERN DELPHI

Appendix B

WESTERN DELPHI PANELS

Region F - - New Mexico

Facilitator: Irving Starbird, USDA, ERS
Resource person: Richard Ridgway, USDA, ARS

Panel members: Claude Hill (cotton producer)

Ted Ramirez (Mobay Co.)

Charles Ward (research entomologist, NM, SE Branch Exp. Station)

Region G - - Central and Southeast Arizona

Facilitator: John R. Schaub, USDA, ERS
Resource person: Brookes Taylor, Univ. of AZ - Tucson

Panel members: Larry Antilla (alternate: Robert Gronowski), AZ State Commission on Agriculture

Dale Fullerton (research entomologist, Univ. of AZ-Mesa)

Greg Hogue (Wilber-Ellis Co.)

Mike Lindsey (independent pest control consultant)

Leon Moore (Extension entomologist, Univ. of AZ)

Sam Stedman (Pinal Co. Ext. Agent)

Howard Wuertz (cotton producer)

Region H - - Imperial, Riverside, Yuma and Mohave Counties

Facilitator: Katherine Reichelderfer, USDA, ERS
Resource person: Thomas Heneberry, USDA, ARS

Panel members: John Benson (cotton producer)

James Carter (AZ State Commission on Agriculture)

David Justice (Arizona Agrochem. Corp.)

James Kaehler (CA State Dept. of Agriculture)

Clyde Shields (independent pest control consultant)

Nick Toscono (Extension entomologist, U.C. - Riverside)

Theo Watson (research entomologist, Univ. of AZ)

Region I - - San Joaquin Valley

Facilitator: Gerald Carlson, N.C. State Univ., Dept. of Economics and Business
Resource person: James Brazzel, USDA, APHIS

Panel members: Hodge Black (Kern Co. Farm Advisor)

Harold Fisher (Chevron Corp.)

Phillip Larson (Wilbur-Ellis Co.)

Tom Leigh (research entomologist, U.S. Cotton Research Station)

O.D. McCutcheon (Kings Co. Farm Advisor)

John Nickelsen (independent pest control consultant)

Fred Starrh (producer, Shafter, CA)

APPENDIX C

WESTERN DELPHI QUESTIONNAIRE

– SAMPLE QUESTIONNAIRE –

I. Current Control Practices

Name: J. Doe
Region: Q

For Use BY Computation Expert

Q1 Target Insect Complexes	Q2 Acreage, OR % Acreage Each Complex	Q3a Most Frequently Used Materials	% use	Q3b Dosage (lbs. a.i./acre)	Q4 Number of Insecticide Applications with Infestation: Zero	Light	Moderate	Heavy	Q5 Probabilities of Infestation: Zero	Light	Moderate	Heavy	Avg Cost	Avg No.
	125,000													
Lygus	43,750	Methyl parathion	.70	0.5	1	1	2	3						
bugs	acres	Malathion	.20	1.0	0	1	2	3	.50	.30	.20	0		
	(35%)	Orthene	.10	1.0	0	2	2	3						
Pink	75,000	Guthion	.75	.60	2	3	4	5						
bollworm	(60%)	Pyrethroids	.15	.10	0	2	3	5	.30	.20	.20	.30		
		Carbaryl	.10	2.0	2	3	5	6						
Bollworm	50,000	B.t.	.10	1.0	1	1	2	3						
(Heliothis)	acres	Azodrin	.65	.75	1	2	3	4						
and	(40%)	Galecron	.15	.125	0	1	2	3	.70	.20	.10	0		
Tobacco budworm		Pyrethroids	.10	.10	0	2	2	3						
All worms	25,000	3+3+ovicide	.15	.5,.5,+.12	0	2	3	5						
(Heliothis	acres	Guthion	.70	.60	1	2	3	5						
and Pink bollworm)	(20%	Pyrethroids	.15	.10	0	2	3	5	.10	.40	.40	.10		
No Insect Problem	0													

-SAMPLE QUESTIONNAIRE -

I. Current Control Practices (continued)

Target Insect Complexes	Q6 Nonchemical Technologies, Information provision or other Insect Control Practices	Q7 Percent of Acres on which Practice Occurs	Q8 Average Cost per Acre of Practice	Q9 Special Problems that may change Cotton Production Costs or Yields for this Complex
Lygus bugs	Trap crop planting	5%	$0.25	
Pink bollworm	Stalk shredding	80%	$ 4.75	
	Fall plow down	20%	$ 3.50	
Bollworm (Heliothis) and Tobacco budworm	Trichogramma release	5%	$35.00	
All worms				
Nonspecific Practices (All insects)	Scouting service	90%	$3.00	

II. Optimum Pest Management

Name: J. Doe
Region: Q

1. CIC Yield (1977-79) : 900 lbs./acre

2. Average cotton lint yield change (pounds/acre) expected under option: 945

   Equals 5 % change from CIC

3. Is the yield change shown above uniformly distributed across acreage in the region?

   /__/ YES   /✓/ NO

   If NO, what is the distribution?

   Acres in Northern areas of region (50% of total acreage) would experience a 2% yield increase.

   Acres in Southern areas of region (50% of total acreage) would experience an 8% increase in yield.

4. Using the format below, please list each factor that contributes to the projected yield change shown above.

Factor	Proportional contribution to yield change
a) Preservation of beneficial species' populations due to postponement of first insecticide treatment.......	80%
b) Increased acreage on which stalk destruction is practiced...	10%
c) Twenty percent increase in planting of resistant varieties....	10%

Expert Enumerator Directions

I. Current Practices in Cotton Insect Control (CIC)

Assume current practices over the past 5 years with currently known and used technology. Remember to describe what you think the average farmers are doing, not what you hope they are doing or think they will be doing in the future. Assume beneficial insects are at average levels.

Q1: Give the major cotton insect pests or pest complexes which farmers face in this area (See map for areas).

(a) Pest complex categories are exhaustive of all pest situations treated at least once per season. Ignore pests never treated for.

(b) Examples of a set of complexes might be: lygus bugs; pink bollworm only; pink bollworm-bollworm (Heliothis)-tobacco budworm; Heliothis (spp).

Q2: What cotton acreage (acres, or percent of total area) in the past 5-10 years falls in each of the pest complex categories? This gives an acreage scaling of the importance of each pest complex.

Q3: For each pest complex list:

(a) Most frequently used materials (common names).

(b) Percentage of farmers (acreage) using each pesticide for this complex. Percentages must add to 100. See the sample questionnaire. For Q3a the complex pink bollworm only has three insecticides listed as most frequently used (guthion, carbaryl, and pyrethroids). The percentages of farmers (acreage) using each are 75, 10 and 15.

Q3b: Average dosages (active ingredients/acre) used for each material listed in Q3a.

Q4: It is necessary for us to estimate the applications per season for each insecticide treatment program in each complex. This will vary by level of insect infestation. Infestation level is defined in terms of the duration of the cotton season the insect complex is present, the percent of one's acreage infested, the level of the pest population, and the susceptibility of the cotton fruit. Give your estimates of the numbers of insecticide applications per season for this complex for each of the four infestation levels. Use the worksheet to arrive at average numbers. (Insert zeros if zero is your estimate.) Please remember that you are estimating what farmers do, not what you recommend. It is widely documented that, in some cases, zero infestation level cotton receives insecticide application.

In the sample questionnaire, Q4 is estimated to be 2, 3, 4, and 5 for the use of guthion on pink bollworms for zero, light, moderate, and heavy infestations, respectively.

Q5: Considering the acreage treated for each complex (see your Q2 entries), what is the probability of zero, light, moderate, and heavy infestations occuring? For example, it may be easiest to think of this as, "How many years in 20 would the average acre have a light infestation?" Frequencies are considered probabilities. Probabilities must add to 1.0 for the four infestation levels.

In the sample questionnaire these figures are 0.3, 0.2, 0.2, and 0.3 for the pink bollworm only complex.

For pest complexes with 2 or more species, consider the sum of the pests, in your definition of zero, light, moderate and heavy, and their related probabilities.

Q6: For each pest complex list all nonchemical control practices used specifically against that target. Identify technologies or services that apply to or are used against all insect pests in the last row labled "Nonspecific Practices".

Q7: For each practice listed in Q6, show the average percent of acreage on which it is currently used.

Q8: For each practice listed in Q6, estimate the average cost per acre paid by growers who utilize it.

Q9: Give special problems for each insect complex that might cause yield or production cost changes.

II. Repeat all of Q1-Q9 under the assumption that "Optimum Pest Management" is implemented and effective (assume no change in cotton acreage).

III. For the Optimum Pest Management (OPM) Program only, complete page 3 of the questionnaire.

1. CIC (current insect control) Yield, 1977-79 will be provided.

2. Show the additional pounds cotton lint per acre (if any) expected as a direct result of an assumed instantaneous change from CIC to OPM. Percent change will be calculated for you.

3. If the yield change identified in question 2 would be restricted to one or a few areas within your region, please indicate the percent of total cotton acreage represented by those areas where change is expected.

4. Please explain and justify the yield change estimate made in questions 2 and 3 by partitioning that change into all identifiable factors estimated to cause it.

APPENDIX D

INSECTICIDE MATERIALS
PRICE LIST

Appendix D

Regions F, G, H: Insecticide Materials Price List

Material	Price per lb. a.i. (1979-80 dollars)
Azodrin (a)	6.45
Bidrin (b)	5.75
Bolstar (a, c)	7.15
Co-mite (b)	6.54
Cygon (Dimethoate; Defend) (a)	6.02
Dipel (B.t.) (a)	8.56
Dylox (c)	2.25
Elcar (d)	8.00
Galecron (Fundal; ovicide) (a)	12.90
Guthion (a, c)	7.84
Kelthane (b)	6.14
Lannate (b, c)	11.35
Lorsban (d)	6.50
Malathion (a, b)	2.37
Methyl parathion (a, c)	2.79
Orthene (Acephate) (b, c)	6.88
Pyrethroids (Pounce; Pydrin; Ambush)	60.00
Sevin (Carbaryl) (a)	2.14
Supracide (c)	6.00
Temik (a)	11.20

Thimet (a)	5.60
Toxaphene (b)	1.39
	Material price per application
Gossyplur (c)	7.75

Sources: a. Table 62. Prices of Selected Chemicals (November 1980), provided by AZ Ext. Service, deflated by 14%.

b. AGCHEMPRICE, December 1980, deflated by 14%.

c. Material provided by Fred Cooke.

d. Regions D and E: Insecticide Materials Price List

APPENDIX E

REGIONAL CONCENSUS RESPONSES TO DELPHI CIC AND OPM QUESTIONNAIRES - - DETAILED DESCRIPTIONS OF WESTERN COTTON INSECT CONTROL PATTERNS

Table E1. Current insect control practices - - San Joaquin Valley

Target insect complex	Percent acreage each complex	Insecticide material	Percent use	Appl. rate 1/	No. insecticide appls. by infestation 2/ Z	L	M	H	Probability of infestation 2/ Z	L	M	H	Avg. cost per acre 3/	Avg. appl. per acre 3/
Spidermites	85	Azodrin	5	.9	1.25	1.25	1.5	1.0	.3	.3	.3	.1	12.17	1.08
		Kelthane	55	1.0	1.25	1.25	1.5	2.0						
		Comite	30	1.25	1.0	1.0	1.0	2.0						
		Sulfur	10	30	1.0	1.0	1.0	1.0						
Spidermites + Lygus	15	Azodrin	10	.9	1	1	0	0	.125	.125	.5	.25	2.85	.20
		Monitor + Comite	30	.4 + 1.25	1	1	1.5	2						
		Lorsban	10	1.0	1	1	1.5	0						
		Orthene + Kelthane	50	.5 + 1.0	1	1	1.5	2						
Lygus	35	Azodrin	5	.6	1	1	1	2.5	.05	.05	.7	.2	3.96	.50
		Dimethoate	20	.5	1	1	1.2	2.5						
		Orthene	40	.5	1	1	1.2	2.5						
		Monitor	20	.5	1	1	1.2	2.5						
		Supracide	10	.5	1	1	1.2	2.5						
		Bidrin	5	.5	1	1	1	2.5						
Lygus	17	Temik	100	1 application									5.10	.17
No Insect Problem	10													

(Table continued, next two pages)

Table E1 (cont.)

Target insect complex	Percent acreage each complex	INSECTICIDE USE BY INSECT COMPLEX							Probability of infestation 2/				Avg. cost per acre 3/	Avg. appl. per acre 3/
		Insecticide material	Percent use	Appl. rate 1/	No. insecticide appls. by infestation 2/									
					Z	L	M	H	Z	L	M	H		
Worms	25	Orthene or Monitor	60	.75	1	1	1.5	1.5	.075	.075	.45	.40	3.32	.33
		Lorsban	10	.75	1	1	1.5	1.5						
		Lannate	10	.45	1	1	1.5	1.5						
		Pyrethroids	10	.15	0	0	0	2						
		Dipel	10	.5	1	1	2	0						

1/ Pounds active ingredient per acre.

2/ Infestation levels: Z = zero; L = light; M = moderate; H = heavy.

3/ Not directly provided by Delphi respondents. Averages are calculated on the basis of insecticide use information and probability of infestation shown in preceeding columns of table.

Table E1 (cont.)

Target Insect Complexes	Nonchemical Technologies Information Provision or other Insect Control Practices	Percent of all Acres on which Practice Occurs	Average Cost per Acre of Practice (dollars)
Spider Mites, Thrips, Aphids	Planting Insecticides (1) seed (2) soil	 80 50	 .90 8.00
All	Scouting	90	5.00
Lygus	Alternate Host. Management	50	15.00
Lygus plus Spider mites	Water and fertilizer management	100	10.00

Table E2. Optimum pest management - - San Joaquin Valley

Target insect complex	Percent acreage each complex	INSECTICIDE USE BY INSECT COMPLEX: Insecticide material	Percent use	Appl. rate 1/	No. insecticide appls. by infestation 2/: Z	L	M	H	Probability of infestation 2/: Z	L	M	H	Avg. cost per acre 3/	Avg. appl. per acre 3/
Spidermites	85	Azodrin	5	.9	1.25	1.25	1.5	1.0	.3	.3	.3	.1	8.40	.85
		Kelthane	55	1.0	1.2	1.2	.4	.6						
		Comite	30	1.25	1.0	1.0	.3	.3						
		Sulfur	10	30	1.0	1.0	1.0	1.0						
Spidermites and Lygus	15	Azodrin	10	.9	1	1	0	0	.125	.125	.5	.25	2.85	.20
		Monitor + Comite	30	.4+1.25	1	1	1.5	2						
		Lorsban	10	1.0	1	1	1.5	0						
		Orthene + Kelthane	50	.5.+ 1.0	1	1	1.5	2						
Lygus	35	Azodrin	5	.6	1	1	1	2.5	.05	.05	.7	.2	3.96	.50
		Dimethoate	20	.5	1	1	1.2	2.5						
		Orthene	4	.5	1	1	1.2	2.5						
		Monitor	2	.5	1	1	1.2	2.5						
		Supracide	10	.5	1	1	1.2	2.5						
		Bidrin	5	.5	1	1	1	2.5						
Lygus (side dress)	8.5	Temik	100	1 application per planted acre									2.55	.085
Worms	25	Orthene or Monitor	60	.75	.9	.9	1.35	1.35	.075	.075	.45	.40	3.02	.30
		Lorsban	10	.75	.9	.9	1.35	1.35						
		Lannate	10	.45	.9	.9	1.35	1.35						
		Pyrethroids	10	.15	0	0	0	1.8						
		Dipel	10	label recom.	1	1	2	0						
No Insect Problem	10								Total per treated acre				18.23	1.85

1/ Pounds active ingredient per acre.
2/ Infestation levels: Z = zero; L = light; M = moderate; H = heavy.
3/ Not directly provided by Delphi respondents. Averages are calculated on the basis of insecticide use information and probability of infestation shown in preceeding columns of table.

Table E2 (cont.)

Target Insect Complexes	Nonchemical Technologies Information provision or other Insect Control Practices	Percent of Acres on all which Practice Occurs	Average Cost per Acre of Practice (dollars)	Special Problems that may change Cotton Production Costs or Yields for this Complex
Spidermites and Thrips	At planting soil seed	 37.5 50	 .90 8.00	
All	Scouting	90	5.00	Improved quality effects shown as part of pesticide use redirection
Lygus	Alternate host management	50	15.00	
Lygus and Spidermites	Water and fertilizer management	100	10.00	

Table E3. Current insect control - - Imperial Valley and Yuma and Mohave Counties.

Target insect complex	Percent acreage each complex	INSECTICIDE USE BY INSECT COMPLEX: Insecticide material	Percent use	Appl. rate 1/	No. insecticide appls. by infestation 2/: Z	L	M	H	Probability of infestation 2/: Z	L	M	H	Avg. cost per acre 3/	Avg. appl. per acre 3/
Thrips, Mites and Others	35	Azodrin	75	.75	.1	.5	1	1.2	.25	.40	.25	.10	2.17	.24
		Sulfur	20	24.5	.5	1.0	1.5	2						
		Others	5	N/A	0	0	1	1						
Lygus, PBW and Leafhoppers	33	Azodrin	30	.80	0	1	1.5	2	.125	.41	.25	.215	3.78	.40
		Other	10	N/A	0	1	1.5	2						
		Orthene	30	1.0	0	1	1.5	2						
		Orthene + Supracide	30	.2 + .44	0	1	1.5	2						
Lygus	30	Azodrin	40	.60	0	1	1	2.5	0	.50	.40	.10	2.75	.34
		Orthene	30	.66	0	1	1	2.5						
		Supracide	20	.25	0	1	1	2.5						
		Dylox + Sulfur	5	1.2 + 2.0	0	1	1	2						
		Temik	5	1.5	1	1	1	1						
Pink bollworm and Lygus	55	Azodrin	40	.80	0	1	1.5	2	.05	.52	.30	.13	5.71	.66
		Pyrethroids	20	.10	0	1	1.2	1.75						
		Supracide	20	.50	0	1	1.5	2						
		Guthion	10	.50	0	1	1.5	2						
		Methyl parathion	10	1.0	0	1	1.5	2						
No Insect Problem	0													

(Table continued, next two pages)

Table E3 (cont.)

Target insect complex	Percent acreage each complex	INSECTICIDE USE BY INSECT COMPLEX: Insecticide material	Percent use	Appl. rate 1/	No. insecticide appls. by infestation 2/				Probability of infestation 2/				Avg. cost per acre 3/	Avg. appl. per acre 3/
					Z	L	M	H	Z	L	M	H		
		Methomyl	35	.45	0	2	2.5	3						
		Pyrethroids	50	.20	0	2	3	4						
Cotton leaf Perforator	20	Temik	5	2.50	1	1	1	1	.10	.30	.30	.30	6.31	.46
		Vydate	10	.25	0	1	1	2						
		Pyrethroids	33	.175	0	4	8	12						
Heliothis, PBW, other worms and mites	90	Pyrethr. + Azodrin	33	.175+1.0	0	4	8	12	0	.25	.50	.25	123.90	7.11
		Pyrethr. + ovicide	28	.175+.16	0	4	8	11						
		Bolstar	6	1.0	0	4	8	10						
		Gossyplure + Pyrethroids	30	recom.	5	5	5	5						
Pink bollworm	90	Guthion	20	.50	0	1	2	3	.10	.20	.35	.35	20.55	2.48
		Pyrethroids	20	.10	0	1	1.5	2						
		Azodrin	10	1.0	0	1	2	3						
		Supracide	20	.50	0	1	2	3						
Totals per acre:													166.17	11.7

1/ Pounds active ingredient per acre.
2/ Infestation levels: Z = zero; L = light; M = moderate; H = heavy.
3/ Not directly provided by Delphi respondents. Averages are calculated on the basis of insecticide use information and probability of infestation shown in preceeding columns of table.

Table E3 (cont.)

Target Insect Complexes	Nonchemical Technologies Information provision or other Insect Control Practices	Percent of Acres on all which Practice Occurs CA	AZ	Average Cost per Acre of Practice ($) CA	AZ
All insects	Scouting by private consultants	50	30	10.00	7.50
	Scouting by chem. reps.	50	70	10.00	7.50
Pink bollworm and Heliothis	stalk destruction and other post harvest operations	99	30	8.00	
Thrips, Mites and Others	Preplant disyston, in-furrow	80	15	4.50	
	seed treatment	75	100	.50	

Table E4. Optimum Pest Management - - Imperial Valley and Yuma and Mohave Counties

Target insect complex	Percent acreage each complex	INSECTICIDE USE BY INSECT COMPLEX			No. insecticide appls. by infestation 2/				Probability of infestation 2/				Avg. cost per acre 3/	Avg. appl. per acre 3/
		Insecticide material	Percent use	Appl. rate 1/	Z	L	M	H	Z	L	M	H		
Thrips, mites and other	35	Azodrin	25	.75	0	.25	.75	1.0	.25	.40	.25	.10	2.51	.27
		Sulfur	55	24.5	.5	1.0	1.5	2						
		Methomyl, Co-mite, Others (mostly Kelthane)	20	N/A	0	0	1	1						
Lygus, PBW and Leafhoppers	25	Azodrin	20	.8	0	1	1.5	2	.125	.41	.25	.215	2.87	.30
		Other	10	.5	0	1	1.5	2						
		Orthene	35	1.0	0	1	1.5	2						
		Orthene + Supracide	35	.64	0	1	1.5	2						
Lygus	30	Azodrin	25	.60	0	.5	1	2.5	0	.50	.40	.10	2.03	.27
		Orthene	40	.66	0	.5	1	2.5						
		Supracide	25	.25	0	.5	1	2.5						
		Dylox	5	1.2	0	.5	1	2.5						
		Dylox + sulfer	5	1.2+ 2.0	0	.5	1	2						
Pink bollworm and Lygus	50	Azodrin	30	.8	0	.5	1	2	.05	.52	.30	.13	3.71	.41
		Pyrethroids	30	.10	0	.5	1	1.75						
		Supracide	30	.50	0	.5	1	2						
		Guthion	10	.50	0	.5	1	2						

(Table continued, next three pages)

Table E4 (cont.)

Target insect complex	Percent acreage each complex	INSECTICIDE USE BY INSECT COMPLEX: Insecticide material	Percent use	Appl. rate 1/	No. insecticide appls. by infestation 2/: Z	L	M	H	Probability of infestation 2/: Z	L	M	H	Avg. cost per acre 3/	Avg. appl. per acre 3/
Cotton leaf Perforator	18	Methomyl	35	.45	0	2	2.5	3	.10	.30	.30	.30	5.68	.42
		Pyrethroids	50	.20	0	2	3	4						
		Temik	5	2.50	1	1	1	1						
		Vydate	10	.25	0	1	1	2						
Heliothis, PBW other worms and mites	90	Pyrethroids	31	.175	0	4	8	12.1	0	.45	.3	.25	104.42	6.14
		Pyr.+ Azodrin	30	.175+1.0	0	4	8	12						
		Pyr.+ ovicide	28	.175+.16	0	4	8	11						
		Bolstar	6	1.0	0	4	8	10						
		Biol. insecticides 2:1, B.t.: Elcar	5	.5 B.t. .25 Elcar	0	2	2	0						
Pink bollworm	90	Gossyplure + Pyr.	30	recom.	5	5	5	5	.10	.20	.35	.35	20.00	2.42
		Guthion	20	.5	0	.5	2	3						
		Pyrethroids	20	.1	0	.5	1.5	2						
		Azodrin	10	1.0	0	.5	2	3						
		Supracide	20	.5	0	.5	2	3						
									Totals, per acre:				141.22	10.23

1/ Pounds active ingredient per acre.
2/ Infestation levels: Z = zero; L = light; M = moderate; H = heavy.
3/ Not directly provided by Delphi respondents. Averages are calculated on the basis of insecticide use information and probability of infestation shown in preceeding columns of table.

Table E4 (cont.)

Target Insect Complexes	Nonchemical Technologies Information provision or other Insect Control Practices	Percent of Acres on all which Practice Occurs		Average Cost per Acre of Practice		Special Problems that may change Cotton Production Costs or Yields for this Complex
		CA	AZ	CA	AZ	
All insects	Scouting, private + chem.	100	100	11.00	10.10	Increased cost due to more frequent scouting.
	Recommended planting dates	25		-1.88		Replanting reduced by 50 percent.
	Recommended maturity dates	22		-0.66		Irrigation cut-off earlier.
Pink bollworm and Heliothis	crop rotation	25	10	N/A		
	stalk destruction, etc	99	40	8.00		
	trapping	55	30	5.00		Average per acre cost; some checked daily, others less frequently.
Thrips, mites and others	preplant di-syston	60	10	4.50		

Table E4 (cont.)

II. Optimum Pest Management--Yield Change from CIC for Imperial Valley Areas

1. CIC Yield (1975-79) : 1087 = weighted average

2. Average cotton lint yield change (pounds/acre) expected under option: 31

   Equals 2.85 % change from CIC

3. Is the yield change shown above uniformly distributed across acreage in the region?
   Yes

4. Using the format below, please list each factor that contributes to the projected yield change shown above.

Factor	Proportional contribution to yield change
Increased recommended planting date	+ 12
Increased rec. maturity date	- 12
Increased crop rotation	+ 15
Increased scouting and trapping and other O. P.	+ 8
Decreased Azodrin and other O. P. use	+ 8
	+ 31

Table E5. Current Insect Control - - Central Arizona

		INSECTICIDE USE BY INSECT COMPLEX			No. insecticide appls. by infestation 2/				Probability of infestation 2/					
Target insect complex	Percent acreage each complex	Insecticide material	Percent use	Appl. rate 1/	Z	L	M	H	Z	L	M	H	Avg. cost per acre 3/	Avg. appl. per acre 3/
Lygus and other plant bugs	75	Orthene	35	0.6	0	0	0.5	1.0	0	0.2	0.5	0.3	2.51	.41
		Supracide	20	0.5	0	0	0.5	1.0						
		Methyl Parathion	45	1.0	0	0	0.5	1.0						
Pink bollworm	80	Methyl Parathion	50	1.2	0.5	1.0	3.0	4.0	0.1	0.3	0.4	0.2	13.31	1.88
		Guthion	10	0.5	0.5	1.0	3.0	4.0						
		Azodrin	20	0.8	0.5	1.0	3.0	4.0						
		Pyrethroids	20	0.1	0.5	1.0	3.0	4.0						
Bollworm/ Tobacco budworm	80	Pyrethroids+ Ovicide	50	0.15 + 0.25	0	0.1	3.5	6.5	0	0.25	0.4	0.35	40.65	2.96
		Pyrethroids	30	0.15	0	0.1	3.5	6.5						
		MP + EPN + Ovicide	15	1.5 +1.0 +0.25	0	0.1	3.5	6.5						
		Azodrin	5	1.0	0	0.1	3.5	6.5						
Leaf Perforator	15	Methomyl	60	0.6	0	0	2.0	4.0	0	0.2	0.5	0.3	3.45	.33
		Pyrethroids	40	0.15	0	0	2.0	4.0						
Mites	30	Kelthane	90	1.3	0	1.0	2.0	3.0	0	0.5	0.4	0.1	5.03	.48
		Azodrin	10	0.8	0	1.0	2.0	3.0						
No Insect Problem	2											Totals:	64.95	6.06

1/ Pounds active ingredient per acre.
2/ Infestation levels: Z = zero; L = light; M = moderate; H = heavy.
3/ Not directly provided by Delphi respondents. Averages are calculated on the basis of insecticide use information and probability of infestation shown in preceeding columns of table.

Table E5 (cont.)

Target Insect Complexes	Nonchemical Technologies Information provision or other Insect Control Practices	Percent of Acres on all which Practice Occurs	Average Cost per Acre of Practice	Special Problems that may change Cotton Production Costs or Yields for this Complex
All insects	Scouting:			Shortage of trained supervisors; Seasonal work
	Purchased	25	6.00	
	Chem. Co.	60	0	
	Other	5	0	
Lygus	Alfalfa management	5	1.00	Irrigation scheduling and harvest of alfalfa plus alfalfa yield loss; Safflower sampling for insects; 50 percent acre custom app'l of Temik-Timing + scheduling
	Safflower treatment	2	2.50	
	Temik	15	25.00	
Pink bollworm	Fall cultural practices (stalk cutting plow, disc)	25	0	Weather considerations; Yield reduction; Lower levels of aflatoxin; Greater technical supervision.
	Variety choice	5	0	
	Irrigation termination	10	-20.00	
	gossyplure disruption	2	30.00	
Bollworm/ Budworm	Irrigation termination	10	-20.00	Possible yield loss; Weather conditions; Aflatoxin decrease.
	Variety choice	10	0	
	Parasite and predators and fruit load	65	0	
Perforators	Water management	5	10.00	
	Temik	10	25.00	application and scheduling
Thrips, Aphids	Temik, Dysyston, thimet, orthene: in furrow or seed treatment	10	5.00	application and scheduling

Table E6. Optimum pest management - - Central Arizona

Target insect complex	Percent acreage each complex	INSECTICIDE USE BY INSECT COMPLEX: Insecticide material	Percent use	Appl. rate 1/	No. insecticide appls. by infestation 2/: Z	L	M	H	Probability of infestation 2/: Z	L	M	H	Avg. cost per acre 3/	Avg. appl. per acre 3/
Lygus and other plant bugs	65	Orthene	40	0.6	0	0	0.7	1.0	0	0.3	0.6	0.1	2.08	.34
		Supracide	25	0.5	0	0	0.7	1.0						
		Methyl parathion	35	1.0	0	0	0.7	1.0						
Pink bollworm	50	Methyl parathion	60	1.2	0.2	1.0	3.0	4.0	0.1	0.3	0.4	0.1	6.54	.96
		Guthion	10	0.5	0.2	1.0	3.0	4.0						
		Azodrin	20	0.8	0.2	1.0	3.0	4.0						
		Pyrethroids	10	0.1	0.2	1.0	3.0	4.0						
Bollworm/ Budworm	40	Pyrethroid	20	0.15	0	0	3.5	6.5	0	0.3	0.5	0.2	15.98	1.13
		Pyrethroid + Ovicide	50	0.15 + 0.25	0	0	3.5	6.5						
		M.P. + EPN + Ovicide	20	1.5 +1.0 + 0.25	0	0	3.5	6.5						
		B.T + Elcar + F.S. 4/	5	0.5 +0.5 + 1.0	0	1.5	0.5	0						
		B.T. + F.S. + Ovicide	5	0.5 +1.0 + 0.25	0	0	1.5	0						
Leaf perforator	10	Methomyl	25	0.6	0	0	2.0	4.0	0	0.3	0.6	0.1	1.17	.12
		Pyrethroid	25	0.15	0	0	2.0	4.0						
		Vydate	50	0.5	0	0	1.0	2.0						
Mites	20	Kelthane	50	1.3	0	1.0	2.0	3.0	0	0.6	0.3	0.1	3.07	.29
		Azodrin	10	0.8	0	0	2.0	3.0						
		Co-mite	40	1.25	0	1.0	2.0	3.0						
No Insect Problem	10											Totals, per acre:	38.84	2.84

1/ Pounds active ingredient per acre.
2/ Infestation levels: Z = zero; L = light; M = moderate; H = heavy.
3/ Not directly provided by Delphi respondents. Averages are calculated on the basis of insecticide use information and probability of infestation shown in preceeding columns of table.
4/ F.S. = feeding stimulant.

Table E6 (cont.)

Target Insect Complexes	Nonchemical Technologies Information provision or other Insect Control Practices	Percent of Acres on all which Practice Occurs	Average Cost per Acre of Practice	Special Problems that may change Cotton Production Costs or Yields for this Complex
All insects	Scouting (purchased)	100	10.00	Shortage of trained supervisors; Seasonal work
	Crop management: Water; Fertility	40	10.00	Shortage of trained supervisors; Seasonal work
Lygus	Alfalfa management	10	1,00	Irrigation scheduling and harvest scheduling; Loss in yield of alfalfa; sampling safflower for insects; Temik app'l timing and scheduling; Subsequent special insect infestations
	Safflower treatment	5	2.50	
	Temik	15	25.00	
Pink bollworm	Fall cultural practices (stalk cutting, plow,disc)	50	0	Weather considerations; Yield reductions; Lower level of aflatoxin; Greater technical supersion
	Variety choice	10	0	
	Irrigation termination	25	-20.00	
	gossyplure control	2	30.00	
Bollworm/ Budworm	Irrigation termination	25	-20.00	Yield loss; Weather conditions; Decrease in aflatoxin
	Variety choice	10	0	
	parasite, predator and fruit load	75	0	
Perforators	Water management	5	10.00	application and scheduling
	Temik	5	25.00	
Thrips - Aphids	Temik Dyston, Thimet, Orthene (in furrow or seed treatment)	10	5.00	Subsequent Heliothis infestations

II. Optimum Pest Management-- Yield Change from CIC for Central Arizona

1. CIC Yield (1977-79) : 1046

2. Average cotton lint yield change (pounds/acre) expected under option: 1100

   Equals 5.16 % change from CIC

3. Is the yield change shown above uniformly distributed across acreage in the region?
   Yes

4. Using the format below, please list each factor that contributes to the projected yield change shown above.

Factor	Proportional contribution to yield change
Crop management	100 percent

Table E7. Insect Control (CIC and OPM) practices - - Southeastern Arizona 4/

Target insect complex	Percent acreage each complex	INSECTICIDE USE BY INSECT COMPLEX: Insecticide material	Percent use	Appl. rate 1/	No. insecticide appls. by infestation 2/: Z	L	M	H	Probability of infestation 2/: Z	L	M	H	Avg. cost per acre 3/	Avg. appl. per acre 3/
Pink bollworm	5	Pidrin	100	.075	.2	1	3	4	.1	.3	.4	.2	.84	0.116
No Insect Problem	95											Totals, per acre:	.84	0.12

1/ Pounds active ingredient per acre.
2/ Infestation levels: Z = zero; L = light; M = moderate; H = heavy.
3/ Not directly provided by Delphi respondents. Averages are calculated on the basis of insecticide use information and probability of infestation shown in preceeding columns of table.
4/ No change in insecticide use or yield projected to result under OPM.

Target Insect Complexes	Nonchemical Technologies Information provision or other Insect Control Practices	Percent of Acres on all which Practice Occurs	Average Cost per Acre of Practice	Special Problems that may change Cotton Production Costs or Yields for this Complex
Pink Bollworm	Mass trap glossy plure	30	$6	Labor intense damage to traps from equipment
Seed corn Maggot Thrips	seed treatment	30	$1	special order of seed

Table E8: Current Insect Control Practices--Upper Rio Grande Valley, New Mexico

Target insect complex	Percent acreage each complex	INSECTICIDE USE BY INSECT COMPLEX											Avg. cost per acre 3/	Avg. appl. per acre 3/
		Insecticide material	Percent use	Appl. rate 1/	No. insecticide appls. by infestation 2/				Probability of infestation 2/					
					Z	L	M	H	Z	L	M	H		
Thrips	5	Bidrin	100	.125	0	0	0	1	0	.70	.25	.05	.01	.003
Lygus-fleahopper	5	Bidrin Dylox Cygon	60 30 10	.219 .5 .33	0 0 0	0 0 0	0 0 0	1 1 1	0	.70	.25	.05	.01	.003
Bollworm	7	Pyrethroids	100	.1	0	0	.5	.5	0	.50	.25	.25	.17	.0175
Bollworm and Beet Armyworm	5	Pyrethroids+ methyl Bolstar	10 90	.1 + .5 1.125	0 0	0 0	.5 .5	.5 .5	0	.80	.10	.10	.06	.005
No Insect Problem	70											Totals:	.25	.03

1/ Pounds active ingredient per acre.
2/ Infestation levels: Z = zero; L = light; M = moderate; H = heavy.
3/ Not directly provided by Delphi respondents. Averages are calculated on the basis of insecticide use information and probability of infestation shown in preceeding columns of table.

Table E8 (cont.)

Target Insect Complexes	Nonchemical Technologies Information provision or other Insect Control Practices	Percent of Acres on all which Practice Occurs	Average Cost per Acre of Practice	Special Problems that may change Cotton Production Costs or Yields for this Complex
Thrips, lygus and fleahoppers	Prophylactic Treatments			
	Temik In-furrow	80	6.00	
	Di-Syston	10	7.70	
	Nemacure	10	10.00	
Lygus and fleahoppers				Acreage of alfalfa increasing.
All Insects	Scouting and Advisory Services:			
	Chem. reps.	50		
	Farmers	25		
Pink bollworms and Heliothis	Shredding and plowdown by 2/1	95	15.00	

Table E9: Optimum Pest Management Practices--Upper Rio Grande Valley, New Mexico

Target insect complex	Percent acreage each complex	Insecticide material	Percent use	Appl. rate 1/	No. insecticide appls. by infestation 2/ Z	L	M	H	Probability of infestation 2/ Z	L	M	H	Avg. cost per acre 3/	Avg. appl. per acre 3/
Thrips	5	Bidrin	100	.125	0	0	0	1	0	.70	.25	.05	.01	.003
Lygus and fleahopper	25	Dylox	50	1.0	0	0	.5	.5	0	.70	.25	.05	.22	.038
		Cygon	25	.33	0	0	.5	.5						
		Orthene	25	.5	0	0	.5	.5						
Bollworms 4/	7	Methomyl, Pyrethroids 5/	15	0.125, .1	0,0	1,0	0,0	0,1	0	.50	.25	.25	.57	.077
		Methomyl + Pyrethroids	15	.125 + 1	0	0	2	0						
		B.K., Elcar	40	.5	0	2	1	0						
		Galecron, Bolstar	40	.125 .5	0,0	1,0	0,0	0						
		Galecron + Bolstar	40	.125 + 5	0	0	2	0						
		Bolstar	5	1.0	0	0	0	1						
Bollworms, Beet Armyworms	5	Bolstar	100	1.125	0	0	.5	.5	0	.80	.10	.10	.04	.005
												Totals:	0.84	0.123

1/ Pounds active ingredient per acre.
2/ Infestation levels: Z = zero; L = light; M = moderate; H = heavy.
3/ Not directly provided by Delphi respondents. Averages are calculated on the basis of insecticide use information and probability of infestation shown in preceeding columns of table.
4/ Percent use of materials for bollworm control sums to greater than 100 percent since some materials or mixes are used only on specific infestation levels.
5/ Indicates sequential applications of two different materials.

Table E9 (cont.)

Target Insect Complexes	Nonchemical Technologies Information provision or other Insect Control Practices	Percent of Acres on all which Practice Occurs	Average Cost per Acre of Practice	Special Problems that may change Cotton Production Costs or Yields for this Complex
Thrips, lygus and fleahoppers	Prophylactic treatments Temik In-furrow Nemocure	 90 10	 7.00 10.00	
Lygus and fleahoppers				Could see an increase in lygus problems as a result of an increase in alfalfa production for increased dairys in area.
All Insects	Scouting and Advisory Srv. Private Chemical industry Grower CES	yrs. 1-3 4 + yrs. 0 20 50 50 15 10 20 0	3.75	
Pink bollworm and Heliothis	Shredding and plowdown 2/1	95	15.00	Same as Pecos Valley

II. Optimum Pest Management

1. CIC Yield (1977-79) : 589

2. Average cotton lint yield change (pounds/acre) expected under option: 40

   Equals 6.8 % change from CIC

3. Is the yield change shown above uniformly distributed across acreage in the region?

4. Using the format below, please list each factor that contributes to the projected yield change shown above.

Factor	Proportional contribution to yield change
More effective control of lygus and fleahoppers; increased bollworm control, if any, offset by the use of biologicals and low rates of selected insecticides.	100%

Table E10. Current Insect Control Practices--Pecos Valley, New Mexico

Target insect complex	Percent acreage each complex	INSECTICIDE USE BY INSECT COMPLEX: Insecticide material	Percent use	Appl. rate 1/	No. insecticide appls. by infestation 2/: Z	L	M	H	Probability of infestation 2/: Z	L	M	H	Avg. cost per acre 3/	Avg. appl. per acre 3/
Thrips	15	Bidrin	100	.125	0	0	1	1.5	0	.2	.5	.3	.60	.14
Lygus and Fleahopper	10	Bidrin Dylox Orthene	85 10 5	.219 .75 .5	0 0 0	0 0 0	.5 .5 .5	1.5 1 1	0	.1	.2	.7	.53	.11
Bollworm (Heliothis)	25	Pyrethroids Lannate, Pyrethroids BT-Elcar, Pyrethroids 4/	85 10 5	.10 .5, .10 .5, .10	0 0,0 0,0	1 2,0 2,0	2 1,1 1,1	3 0,3 0,3	0	.5	.3	.2	4.17	.44
Bollworm-Budworm and Beet armyworm	15	Bolstar	100	1.125	0	0	1	2	0	.6	.2	.2	.72	.09
No Insect Problem	50								Totals, per acre:				6.02	.78

1/ Pounds active ingredient per acre.
2/ Infestation levels: Z = zero; L = light; M = moderate; H = heavy.
3/ Not directly provided by Delphi respondents. Averages are calculated on the basis of insecticide use information and probability of infestation shown in preceeding columns of table.
4/ Indicates sequential applications of two different materials.

Table E10 (cont.)

Target Insect Complexes	Nonchemical Technologies Information provision or other Insect Control Practices	Percent of Acres on all which Practice Occurs	Average Cost per Acre of Practice	Special Problems that may change Cotton Production Costs or Yields for this Complex
Thrips	Temik in-furrow at planting	50	6.00	Seedling disease problems could increase thrips treatments.
	Disyston in-furrow at planting	4	7.70	
	Seed treatment with Disyston	10	1.00	
Lygus - fleahopper				Adjacent fields of alfalfa-no strip cutting- increases lygus problem, especially with problems of growing season over last 5 years (300-400 fewer heat units). Treatment has upset bollworm predators.
Bollworm	Parasites-predators (Trichogramma and Ladybird beetles)	.005	30.00	
All Insects	Scouting-advisory:		3.75	
	(1) Private	16		
	(2) Chemical industry	60		
	(3) Grower scouting	15		
Pink bollworm, Heliothis	Shredding and plowdown by 2/1	90	15.00	

Table E11. Optimum Pest Management Practices--Pecos Valley, New Mexico

Target insect complex	Percent acreage each complex	INSECTICIDE USE BY INSECT COMPLEX							Probability of infestation 2/				Avg. cost per acre 3/	Avg. appl. per acre 3/
		Insecticide material	Percent use	Appl. rate 1/	No. insecticide appls. by infestation 2/									
					Z	L	M	H	Z	L	M	H		
Thrips	10	Bidrin	100	.125	0	0	1	1.5	0	.20	.50	.30	.40	.095
Lygus and fleahoppers	70	Dylox	60	.75	0	0	1	1.5	0	.10	.20	.70	5.06	.875
		Orthene	35	.5	0	0	1	1.5						
		Bidrin	5	.219	0	0	1	1.5						
Bollworm (Heliothis) 4/	35	Galecron	40	.125	0	1	0	0	0	.50	.40	.10	3.46	.45
		Galecron + Bolstar	40	.125 .5	0	0	2	0						
		Bolstar	5	1.0	0	0	0	1						
		Methomyl + Pyrethroids	15	0.125 + .1	0	0	2	0						
		Methomyl	15	.125	0	1	0	0						
		Pyrethroids	15	.10	0	0	0	1						
		B.t. or Elcar	40	.5	0	2	1	0						
Bollworm-budworm, and beet armyworms	15	Bolstar	100	1.125	0	0	1	2	0	.6	.2	.2	.72	0.09
Not treated	25											Totals:	9.64	1.51

1/ Pounds active ingredient per acre.
2/ Infestation levels: Z = zero; L = light; M = moderate; H = heavy.
3/ Not directly provided by Delphi respondents. Averages are calculated on the basis of insecticide use information and probability of infestation shown in preceeding columns of table.
4/ Percent use of materials for bollworm control sums to greater than 100 percent since some materials or mixes are used only on specific infestation levels.

Table Ell (cont.)

Target Insect Complexes	Nonchemical Technologies Information provision or other Insect Control Practices	Percent of Acres on all which Practice Occurs	Average Cost per Acre of Practice	Special Problems that may change Cotton Production Costs or Yields for this Complex
Thrips	Prophylactic treatments Temik in-furrow at planting Di-Syston in-furrow at planting Seed treatment Di-Syston Orthene	 65 0 10	 6.00 1.00	Assuming the main limitation of the use of foliar applications is lack of application equipment and poor timing of foliar treatment.
Lygus and fleahoppers				Due to current irrigation and agronomic alflafa production practices, the acceptance of managing alternate hosts will have a minor impact.
Bollworm	Parasites-Predators (Natural) P and P release	? 0.05	 30.00	Additional information is needed on the impact of insecticide on these, especially parasites.
All Insects	Scouting advisory (1) Private (2) Chemical industry (3) Grower scouting (4) CES	yrs. 1-3 yr. 4+ 25 60 50 50 15 10 25 0	 4.50 4.50	Scouting is 100 + percent of the acreage due to overlapping of chemical industry and grower scouting.
Pink bollworm, Heliothis	Shredding and plowdown by 2/1	90	15.00	This has become a standard agronomic practice where weather permits and may help prevent the reappearance of this major pest.

Table E11 (cont.)

II. Optimum Pest Management--Yield Change from CIC to OPM in Pecos Valley

1. CIC Yield (1977-79) : 525

2. Average cotton lint yield change (pounds/acre) expected under option: 85

   Equals 16.2 % change from CIC

3. Is the yield change shown above uniformly distributed across acreage in the region?

4. Using the format below, please list each factor that contributes to the projected yield change shown above.

Factor	Proportional contribution to yield change
1. More effective thrips control resulting in healthier cotton getting off to a faster start. Less susceptibility to seedling disease.	5 percent of change
2. Increased awareness of lygus-fleahopper problems and importance of early fruit set. In this area, 80 percent of crop is set in first 3 weeks of fruit set. The efficient use of biologicals and low rates of other selected insecticides are expected to offset the increased bollworm control, if any, as a result of the increase in early insect control.	95 of change

Table E12. Current Insect Control Practices--Southern Plains of New Mexico

Target insect complex	Percent acreage each complex	INSECTICIDE USE BY INSECT COMPLEX: Insecticide material	Percent use	Appl. rate 1/	No. insecticide appls. by infestation 2/: Z	L	M	H	Probability of infestation 2/: Z	L	M	H	Avg. cost per acre 3/	Avg. appl. per acre 3/
Thrips and aphids	15	Bidrin	100	0.125	0	0	0	1	0	.20	.35	.45	.28	.07
Fleahoppers and lygus	5	Bidrin	30	0.219	0	0	.5	.5	0	.55	.30	.15	.05	.008
		Azodrin	50	.75	0	0	.5	.5						
		Toxaphene	20	2.5	0	0	.5	.5						
Bollworms	10	Azodrin	65	.75	0	1	2	4	0	.60	.30	.10	1.33	.16
		Pyrethroids	15	.1	0	1	2	4						
		Toxaphene	10	3.0	0	1	2	4						
		Lannate-Nudrin	10	.5	0	1	2	0						
Bollworms and beet armyworms	8	Pyrethroids	45	.1	0	0	0.5	0.75	0	.70	.20	.10	.15	.014
		Bolstar	5	1.125	0	0	0.5	0.75						
		Azodrin	50	1.25	0	0	0.5	0.75						
No Insect Problem	80											Totals:	1.81	0.25

1/ Pounds active ingredient per acre.
2/ Infestation levels: Z = zero; L = light; M = moderate; H = heavy.
3/ Not directly provided by Delphi respondents. Averages are calculated on the basis of insecticide use information and probability of infestation shown in preceeding columns of table.

Table E12 (cont.)

Target Insect Complexes	Nonchemical Technologies Information provision or other Insect Control Practices	Percent of Acres on all which Practice Occurs	Average Cost per Acre of Practice	Special Problems that may change Cotton Production Costs or Yields for this Complex
Thrips	Prophylactic treatments of: Temik In-furrow at Plant. (0.3) Di-Syston In-furrow at Plant. (0.75) Prophylactic seed treatments with Di-Syston	 20 5 30	 6.00 6.00 1.00	Migration of thrips from maturing small grain fields causes most of these infestations, especially in Roosevelt Co.
All insects	Scouting and advisory service	Grower scouting 5 Chemical industry 10	included in chemical	

Table E13. Optimum Pest Management Practices--Southern Plains of New Mexico

Target insect complex	Percent acreage each complex	INSECTICIDE USE BY INSECT COMPLEX							Probability of infestation 2/				Avg. cost per acre 3/	Avg. appl. per acre 3/
		Insecticide material	Percent use	Appl. rate 1/	No. insecticide appls. by infestation 2/									
					Z	L	M	H	Z	L	M	H		
Thrips and Aphids	20	Bidrin	100	0.125	0	0	0	1	0	.20	.35	.45	.38	.09
Fleahoppers and lygus	25	Dylox	50	.6	0	0	.5	.5	0	.55	.30	.15	.30	.056
		Orthene	50	.35	0	0	.5	.5						
Bollworms 4/	10	Methomyl,		.15	0	1	0	0	0	.60	.30	.10	.94	.128
		Pyrethroids		.15	0	0	0	1						
		Methomyl + Pyrethroids	15	0.125 + .1	0	0	2	0						
		B.t., Elcar	40	.5	0	2	1	0						
		Galecron + Bolstar	40	.125 + .5	0	0	2	0						
		Bolstar	5	1.0	0	0	0	1						
		Galecron	40	.125	0	1	0	0						
Bollworms + Beet armyworms	5	Bolstar	100	1.125	0	0	.5	.5	0	.70	.20	.10	.48	.06
No Insect Problem	55											Totals:	2.10	.33

1/ Pounds active ingredient per acre.
2/ Infestation levels: Z = zero; L = light; M = moderate; H = heavy.
3/ Not directly provided by Delphi respondents. Averages are calculated on the basis of insecticide use information and probability of infestation shown in preceeding columns of table.
4/ Percent use of materials for bollworm control sums to greater than 100 percent since some materials or mixes are used only on specific infestation levels.

Table E13 (cont.)

Target Insect Complexes	Nonchemical Technologies Information provision or other Insect Control Practices	Percent of Acres on all which Practice Occurs	Average Cost per Acre of Practice
Thrips	Prophylactic treatments of Temik In-furrow at planting 0.3	25	6.00
	Di-Syston In-furrow at planting 0.75	5	6.00
	Prophylactic seed treatments with Di-Syston, Orthene	35	1.00
All Insects	Scouting and advisory services	yrs. 1-3 / 4 + yrs.	
	(1) Private industry	0 / 20	4.50
	(2) Chemical industry	10 / 10	
	(3) Grower scouting	5 / 5	
	(4) CES	20 / 0	4.50

Table E13 (cont.)

II. Optimum Pest Management--Yield change from CIC to OPM for Southern Plains

1. CIC Yield (1977-79) : 321 (includes both dryland and irrigated)

2. Average cotton lint yield change (pounds/acre) expected under option: 25 (irrigated only)

   Equals 7.8 % change from CIC

3. Is the yield change shown above uniformly distributed across acreage in the region?

4. Using the format below, please list each factor that contributes to the projected yield change shown above.

Factor	Proportional contribution to yield change
1. Increased thrips control.	10%
2. Increased fleahopper and lygus control with increased bollworm control, if any, off-set by the use of biologicals and low rate of selected insecticides.	90%

APPENDIX F

DELPHI CRITIQUE FORM

AND

SUMMARY OF RESPONSES TO DELPHI CRITIQUE

DELPHI CRITIQUE FORM 1/

A. Your role in the Delphi process:

- /__/ Panel Member
- /__/ Resource person
- /__/ Facilitator
- /__/ Administrator

B. Delphi panel with which you participated (if applicable):

- /__/ San Joaquin
- /__/ Imperial, Riverside, Yuma, and Mohave Counties
- /__/ Central and Southeast Arizona
- /__/ New Mexico

C. PANEL MEMBERS ONLY:

Please indicate the extent of your agreement or disagreement with each of the following statements regarding the Delphi by checking the appropriate box. ALL OTHER PARTICIPANTS SKIP TO ITEM D, on page 6.

1. The resource presentations made during the first morning of the Phoenix meeting were helpful to me in terms of responding to the Delphi questionnaire.

		Number (%) of responses
/__/	Strongly agree	1 (5%)
/__/	Agree	16 (90%)
/__/	Agree somewhat	1 (5%)
		18
/__/	No opinion	
/__/	Disagree somewhat	
/__/	Disagree	
/__/	Strongly disagree	

Average response: 2/

SA	A	AS	DS	D	SD
I	I	I	I	I	I
	*				
	*				

1/ Includes summary of responses. The number of responses in each response category and the percentage of total responses falling in each category are shown for each of statements 1-22.

2/ The average of all responses is indicated by a set of asterisks (*) placed along a scale of response categories. Abbreviations are as follows: SA = strongly agree; A = agree; AS = agree somewhat; DS = disagree somewhat; D = disagree; and SD = strongly disagree.

2. I was provided, or could obtain on my·own, the background information necessary to respond to the Delphi questionnaire.

Number (%) of responses

/__/ Strongly agree

/__/ Agree....................................14 (78%)

/__/ Agree somewhat...........................1 (5%)

/__/ No opinion...............................1 (5%)

/__/ Disagree somewhat........................2 (11%)
18

/__/ Disagree

/__/ Strongly disagree

Average response:

SA	A	AS	DS	D	SD
I	I	I	I	I	I
	*				
	*				

3. The questions on the Delphi questionnaire were precise and unambiguous.

Number (%) of responses

/__/ Strongly agree

/__/ Agree....................................7 (39%)

/__/ Agree somewhat...........................7 (39%)

/__/ No opinion

/__/ Disagree somewhat........................4 (22%)
18

/__/ Disagree

/__/ Strongly disagree

Average response:

SA	A	AS	DS	D	SD
I	I	I	I	I	I
	*				
	*				

4. It was difficult to use the Delphi questionnaire to describe the average insecticide use patterns I believed would result under alternative cotton insect management programs.

	Number (%) of responses
/_/ Strongly agree	1 (5%)
/_/ Agree	4 (22%)
/_/ Agree somewhat	6 (33%)
/_/ No opinion	1 (5%)
/_/ Disagree somewhat	3 (17%)
/_/ Disagree	3 (17%)
	18
/_/ Strongly disagree	

Average response:

```
SA       A        AS       DS       D        SD
I        I        I        I        I        I
_____________________________________________
                     *
                     *
```

5. The facilitator for my group prevented domination of the group activities by any one or a few individuals.

	Number (%) of responses
/_/ Strongly agree	5 (28%)
/_/ Agree	12 (67%)
/_/ Agree somewhat	
/_/ No opinion	
/_/ Disagree somewhat	1 (5%)
	18
/_/ Disagree	
/_/ Strongly disagree	

Average response:

```
SA       A        AS       DS       D        SD
I        I        I        I        I        I
_____________________________________________
       *
       *
```

6. **The facilitator did not attempt to influence the outcome of the exercise by suggesting responses.**

Number (%) of responses

/_/ Strongly agree 6 (33%)

/_/ Agree 11 (66%)

/_/ Agree somewhat

/_/ No opinion

/_/ Disagree somewhat

/_/ Disagree..................................1 (5%)

18

/_/ Strongly disagree

Average response:

SA	A	AS	DS	D	SD
I	I	I	I	I	I
	*				
	*				

7. **The Delphi process allowed me the freedom to disagree with other panel members.**

Number (%) of responses

/_/ Strongly agree 7 (39%)

/_/ Agree 10 (56%)

/_/ Agree somewhat

/_/ No opinion

/_/ Disagree somewhat 1 (5%)

18

/_/ Disagree

/_/ Strongly disagree

Average response:

SA	A	AS	DS	D	SD
I	I	I	I	I	I
*					
*					

8. The Delphi process provided the opportunity for anonimity of my responses to the questionnaire.

Number (%) of responses

/ / Strongly agree 3 (17%)

/ / Agree 8 (44%)

/ / Agree somewhat..............................4 (22%)

/ / No opinion 2 (11%)

/ / Disagree somewhat..........................1 (5%)
18

/ / Disagree

/ / Strongly disagree

Average response:

SA	A	AS	DS	D	SD
I	I	I	I	I	I
		*			
		*			

9. If given the opportunity, I would be willing to serve as an expert panel member in another similar Delphi exercise.

Number (%) of responses

/ / Strongly agree 3 (17%)

/ / Agree 13 (72%)

/ / Agree somewhat 1 (5%)

/ / No opinion

/ / Disagree somewhat

/ / Disagree 1 (5%)
18

/ / Strongly disagree

Average response:

SA	A	AS	DS	D	SD
I	I	I	I	I	I
	*				
	*				

D. ALL DELPHI PARTICIPANTS, INCLUDING PANEL MEMBERS: Please indicate the extent of your agreement or disagreement with each of the following statements regarding the Delphi by checking the appropriate box.

10. The Delphi regional panels were made up of individuals with a high degree of expertise in cotton insect management.

	Number (%) of responses
/__/ Strongly agree	16 (57%)
/__/ Agree	11 (39%)
/__/ Agree somewhat	
/__/ No opinion	
/__/ Disagree somewhat	1 (4%)
	28
/__/ Disagree	
/__/ Strongly disagree	

Average response:

SA	A	AS	DS	D	SD
I	I	I	I	I	I

*
*

11. The Delphi panels included individuals with a range of perspectives and experiences.

	Number (%) of responses
/__/ Strongly agree	15 (54%)
/__/ Agree	11 (39%)
/__/ Agree somewhat	2 (7%)
	28
/__/ No opinion	
/__/ Disagree somewhat	
/__/ Disagree	
/__/ Strongly disagree	

Average response:

SA	A	AS	DS	D	SD
I	I	I	I	I	I

*
*

12. **The Delphi panels were not biased with respect to overrepresentation by any one subgroup of individuals.**

	Number (%) of responses
/__/ Strongly agree	9 (33%)
/__/ Agree	16 (59%)
/__/ Agree somewhat	1 (4%)
/__/ No opinion	
/__/ Disagree somewhat	1 (4%)
	27
/__/ Disagree	
/__/ Strongly disagree	

Average response:

SA	A	AS	DS	D	SD
I	I	I	I	I	I
	**				

13. **The Delphi process was well organized and proceeded in an efficient manner.**

	Number (%) of responses
/__/ Strongly agree	11 (39%)
/__/ Agree	16 (57%)
/__/ Agree somewhat	1 (4%)
	28
/__/ No opinion	
/__/ Disagree somewhat	
/__/ Disagree	
/__/ Strongly disagree	

Average response:

SA	A	AS	DS	D	SD
I	I	I	I	I	I
**					

14. The Delphi estimates are realistic representations of the average situations expected for an average year under the conditions described by program definitions.

	Number (%) of responses
/_/ Strongly agree	3 (11%)
/_/ Agree	14 (52%)
/_/ Agree somewhat	5 (19%)
/_/ No opinion	2 (7%)
/_/ Disagree somewhat	2 (7%)
/_/ Disagree	1 (4%)
	27
/_/ Strongly disagree	

Average response:

SA A AS DS D SD
I I I I I I
*
*

15. I believe the face-to-face interaction provided for among participants led to better estimates than could have been collected through a mail survey or other individual based survey methods.

	Number (%) of responses
/_/ Strongly agree	13 (48%)
/_/ Agree	13 (48%)
/_/ Agree somewhat	1 (4%)
	27
/_/ No opinion	
/_/ Disagree somewhat	
/_/ Disagree	
/_/ Strongly disagree	

Average response:

SA A AS DS D SD
I I I I I I
*
*

16. The Delphi review and revision process was prematurely ended. More study and review time was needed.

	Number (%) of responses
/_7 Strongly agree	1 (4%)
/_7 Agree	1 (4%)
/_7 Agree somewhat	6 (22%)
/_7 No opinion	1 (4%)
/_7 Disagree somewhat	2 (7%)
/_7 Disagree	14 (52%)
/_7 Strongly disagree	2 (7%)
	27

Average response:

SA	A	AS	DS	D	SD
I	I	I	I	I	I
			* *		

17. A byproduct of the Delphi meetings has been increased understanding and communication among cotton experts from various States and in various scientific disciplines.

	Number (%) of responses
/_7 Strongly agree	5 (19%)
/_7 Agree	11 (41%)
/_7 Agree somewhat	5 (18%)
/_7 No opinion	5 (18%)
/_7 Disagree somewhat	1 (4%)
	27
/_7 Disagree	
/_7 Strongly disagree	

Average response:

SA	A	AS	DS	D	SD
I	I	I	I	I	I
	* *				

18. **Participation in the Delphi process was a waste of my time.**

	Number (%) of responses
/__/ **Strongly agree**	
/__/ **Agree**	
/__/ **Agree somewhat**	1 (4%)
/__/ **No opinion**	1 (4%)
/__/ **Disagree somewhat**	1 (4%)
/__/ **Disagree**	12 (44%)
/__/ **Strongly disagree**	12 (44%)
	27

Average response:

SA	A	AS	DS	D	SD
I	I	I	I	I	I
				*	
				*	

19. The Delphi results provided the best possible beltwide estimates of average subregional farm level impacts of a change in cotton insect management programs given: current state of knowledge and time constraints.

	Number (%) of responses
/__/ **Strongly agree**	5 (19%)
/__/ **Agree**	17 (63%)
/__/ **Agree somewhat**	2 (7%)
/__/ **No opinion**	1 (4%)
/__/ **Disagree somewhat**	2 (7%)
	27
/__/ **Disagree**	
/__/ **Strongly disagree**	

Average response:

SA	A	AS	DS	D	SD
I	I	I	I	I	I
	*				
	*				

E. Please estimate the number of man-hours you devoted to participation in the Cotton Insect Management Evaluation Delphi process. Include in your estimate time spent preparing for and attending the meeting and, if applicable, revising estimates, providing rationales, preparing resource presentations and materials.

sum of responses equals

837 **man-hours** = 0.4 man years